Faculty of Engineering and Computing

Department of Civil Engineering

Performance, Evaluation, and Enhancement of Red Sand for Road Bases, Embankments, and Seawall Fills

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DECLARATION

This thesis contains no material which has been accepted for the award of any other degree or diploma in any university.

To the best of my knowledge and belief this thesis contains no material previously published by any other person except where due acknowledgment has been made.

The following publications have resulted from the work carried out for this degree.

Refereed Journal and Conference Papers:

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2. **Jitsangiam, P.**, Nikraz, H., and Jamieson, E., (2007). “Sustainable Use of a Bauxite Residue (red sand) in terms of Roadway Materials” *International Conference on Sustainability Engineering and Science*, Auckland, New Zealand. 20th-23rd February, CD-ROM.

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4. **Jitsangiam, P.**, Nikraz, H., (2007). "Static and repeated loading triaxial testing of Hydrated Cement Treated Crushed Rock Base (HCTCRB)" *10th Australia New Zealand Conference on Geomechanics,* Brisbane, 21st-24th October, pp. 478-483.

5. **Jitsangiam, P.**, Nikraz, H., (2007). "Geotechnical Characteristics of the Hydrated Cement Treated Crushed Rock Base (HCTCRB) in Western Australia" *2nd International Geo-Changsha Conference*, Changsha-Hunan, China, 28th-30th November, accepted.

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Performance, Evaluation, and Enhancement of Red Sand for Road Bases, Embankments, and Seawall Fills

ABSTRACT

Australia produces approximately 40% of the world's bauxite and over 30% of the world's alumina. Each year, about 25 million tonnes of bauxite residue is produced in Australia, requiring storage and maintenance. The construction and operation of such large impoundment areas is costly. During the extraction of alumina from bauxite ore using the Bayer process, a fine residue is produced called Red Mud. In West Australia, Darling Range bauxite deposits contain high levels of quartz which result in a coarse residue fraction also being produced. This fraction has been termed Red Sand with a typical particle size in excess of 90 microns. Typically, red mud and red sand are produced in almost equal quantity. Processing of red sand can neutralise the residual caustic and lower the salt content as required. Magnetic separation is also possible to produce a high silica fraction having low iron oxide content. The sustainable use of coarse bauxite residues for road construction is an attractive option with a high potential for large volume reuse.

This study focuses on whether red sand is a viable option for use as a road base, embankment fills and as seawall fills in Western Australia. Red sand comes from bauxite ore, a product of intense tropical weathering. Hence, there are various physical properties resulting from the weathering process. Thus it is necessary to fully understand the characterisation of red sand with respect to its engineering properties in the initial part of this research. To satisfy minimum requirements of road bases, a soil stabilisation technique (a Pozzolanic- Stabilised Mixture, PSM) was used. The intent of this stabilisation technique was to use Western Australia's by-products as stabilising materials. A Pozzolanic - Stabilised Mixture consisting of Class F fly ash (a by-product from a coal power station) and activators (the by-product from the quicklime manufacturing in terms of lime kiln dust) were employed to develop pozzolanic activity. Once the appropriate mixture of red sand, fly ash, and activators was established (based on a maximum dry density and a value of unconfined compressive strength), a set of laboratory tests were performed which included a triaxial compressive strength test, a resilient modulus test, and a permanent deformation test. Comparisons were made between the stabilised red sand and the conventional road base material in Western Australia (crushed rock added with 2% General Purpose (GP) Portland Cement named Hydrated Cemented Treated Crushed Rock Base, HCTCRB). As for the use of red sand for embankments, the representative stabilised red sand (from red sand for road bases) was used to be an alternative fill embankment material. A testing program to evaluate the important properties of stabilised red sand for embankments including permeability, compressibility and strength was undertaken. The permeability, compressibility, and strength of the representative type of red sand were examined to assess the suitability of red sand as seawall fill. The application of red sand and stabilised red sand on three structures (road bases, embankments and seawalls) is also discussed.

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e	=	Void ratio
k	=	A factor used in the calculation of N (k=280 for E=2000 MPa; k=200 for E=5000 MPa; k=150 for E=10000MPa)
m	=	Moisture content (%)
v	=	Poisson's ratio
A_v	=	Air void (%)
Al_2O_3	=	Aluminium oxide
C_c	=	Coefficient of curvature
C_u	=	Coefficient of uniformity
CaO	=	Calcium oxide
CBR	=	California bearing ratio
CH	=	refer to unified soil classification chart of Unified Soil Classification
CL	=	refer to unified soil classification chart of Unified Soil Classification
CGF	=	Cumulative growth factor
D_{10}	=	Particle size at 10% passing
D_{30}	=	Particle size at 30% passing
D_{60}	=	Particle size at 60% passing
FA	=	Fly ash
Fe_2O_3	=	Iron oxide
Gs	=	Specific gravity
H_v	=	Heavy vehicle (%)
K_2O_3	=	Potassium oxide
LDF	=	Lane distribution factor
LKD	=	Lime kiln dust
LOI	=	Loss on ignition

MgO	=	Magnesium oxide
MDD	=	Maximum dry density
M_r	=	Resilient modulus
Na_2O	=	Sodium oxide
OMC	=	Optimum moisture content
P_2O_5	=	Phosphorus pentoxide
RS	=	Red sand
SC	=	Refer to unified soil classification chart of Unified Soil Classification
SiO_2	=	Silica oxide
SP	=	Refer to unified soil classification chart of Unified Soil Classification
SW	=	Refer to unified soil classification chart of Unified Soil Classification
TiO_2	=	Titanium oxide
V	=	Total soil volume (solid, water and air voids)
V_a	=	Volume of air void
V_B	=	percentage by volume of bitumen in the asphalt
V_s	=	Volume of solid
V_w	=	Volume of water
γ_d	=	Dry density
γ_w	=	Density of water at room temperature
ρ_w	=	Water density
ρ_s	=	Solid density
σ_1	=	Normal stress
σ_3	=	Confining stress

CHAPTER 1

INTRODUCTION

1.1 Objective and scope

The objective of this research is to outline opportunities to use red sand for the construction of road bases, embankments, and seawall fills. Specifically, this research aims to:

i) Study the characteristics of red sand in terms of its physical and geotechnical engineering properties as detailed below:

- *Physical properties* with respect to: shape and size of bauxite grains; colour and surface texture; specific gravity; natural water content; and density.

- *Geotechnical engineering properties* with respect to: gradation; consistency; maximum and minimum density; permeability; compressibility (to consider behaviour of red sand during uploading and reloading, the relation of strain- stress from the one-dimensional consolidation test); strength (the strength characteristic of red sand during various loading conditions will be simulated and strength test methods such as a triaxial test and direct shear test will be utilised); and compaction.

ii) Determine a suitable stabilisation method for red sand dependent upon its properties. Mechanical and chemical stabilisation techniques will be investigated with the aim of stabilising red sand properties such that they will be not be significantly deteriorated by environmental effects and loading conditions.

iii) Study the engineering properties of stabilised red sand following appropriate stabilisation techniques. The test of its strength, compressibility, permeability, and durability will be conducted, as well as the determination of the resilient modulus characteristics and permanent characteristics for road base design.

iv) Make comparisons of the properties of the red sand and suitably stabilised red sand with the minimum requirements of road bases, embankments, and seawall fills.

v) Evaluate the potential use of stabilised red sand and red sand for the construction of road bases, embankments, and seawall fills based on experimental results.

1.2 Background

The aluminium and bauxite industry in Australia consists of five bauxite mines, six alumina refineries, six primary aluminium smelters, twelve extrusion mills, and four rolled product mills. From these, Australia produced 53.0 Mt of bauxite and 16.5 Mt of alumina and 1.9 Mt of aluminium in 2003. This represented 40% of the western world's production output for that year. The most significant deposits of bauxite in Australia are located at Weipa in northern Queensland, on the Gove Peninsula in the Northern Territory, and in the Darling Range and

Mitchell Plateau areas of Western Australia where deposits are uneconomic to develop, but important for future resources.

In Western Australia, numerous bauxite deposits, located in the Darling Ranges south of Perth, have underpinned the long-term development of the Alumina industry. Western Australia has four alumina refineries, three owned by Alcoa World Alumina (Alcoa) and located at Kwinana, Pinjarra and Wagerup; and one owned by Worsley JV, at Worsley near Collie. In 2004, the total combined Alumina production of the four refineries was approximately 11 Mt per a year.

The Australian aluminium industry is aware its long term viability depends on responsible resource management. Alcoa has conducted a research program on the utilisation of bauxite residues for many years and is co-operating with The Centre for Sustainable Resource Processing (CSRP), various Universities, and institutes throughout Australia.

Previous research into bauxite residues tended to investigate the utilisation of red mud, which is a fine- grained residue. Zang et al. (2001) studied the physical, chemical, and mineral properties of bauxite residues from an aluminium factory in China. They identified its undesirable engineering properties and recommended methods for storing, reinforcing, and utilising the red mud particular to the area of China. The authors concluded that red mud could be used as roadbed materials, as a silicate cement product, and as silicate fertiliser.

A review by Paramguru et al. (2005) reported that the standard practice for disposal of red mud was to discharge it into the sea or impoundment. A number of utilisation strategies have been worked out by alumina plants to deal with the waste, landfill, land reclamation, and specific uses such as building materials and inorganic chemicals. The authors also reported that economic evaluation of specific process strategies to recover valuable metals has depended on the composition of the red mud.

Newton et al. (2006) described a laboratory program to investigate the mechanical and physicochemical properties of bauxite residue (red mud) in the United Kingdom and found that the red mud storage facility was considered for future rehabilitation and construction activity. Red mud has compression behaviours similar to clayey soils, but a frictional behaviour closer to sandy soils and appears to be structured with features consistent with sensitive, cemented clay soils.

Cooling and Jamieson (2004) have grouped the most promising large volume products from bauxite residues into three types: Red Sand, ALKALOAM® (carbonated red mud), and REDLIME™ (solid lime residue product). Alcoa has isolated the red sand neutralised the residual caustic through carbonation, and then washed it free of salt. Their initial report suggests this sand would be suitable as fills and for construction.

An attractive way to reduce bauxite residues efficiently is to use it as a fill material, because a large amount of fill material is required to make the appropriate elevations and areas for construction in new development projects. Thus the available opportunity to use red sand as a fill material according to conducting method applied on red mud is interesting to study.

1.3 Significance

The significance of developing this research is that the research outcome would be in reducing bauxite residues from the alumina industry by using one of the main waste products (red sand). There would also be a new large volume source of construction materials available as traditional sources are in decline. This could reduce construction costs and provide another choice for construction materials. Sine red sand is already produced as a by-product of an industrial process, use of these materials would significantly contribute towards sustainability and residue utilisation.

1.4 Research approach

To achieve the objective of this research, the study will be carried out following the methodology as shown in figure 1.1.

Literature review

For the first stage of this research, a detailed review of the literature relevant to red sand and other bauxite waste residues, including the study of industrial waste utilisation, will be carried out in order to assess the current stage of knowledge available for developing this research.

Characterisation of red sand

In the second stage, all essential properties of red sand will be investigated, with respect to physical and engineering properties. Because red sand comes from the bauxite, which is the weathered rock, its properties can be variable as a result of that weathering process. It is necessary to examine all properties of red sand experimented in this research. The understanding about such material properties will be fundamental in explaining the behaviour of red sand used in various construction activities.

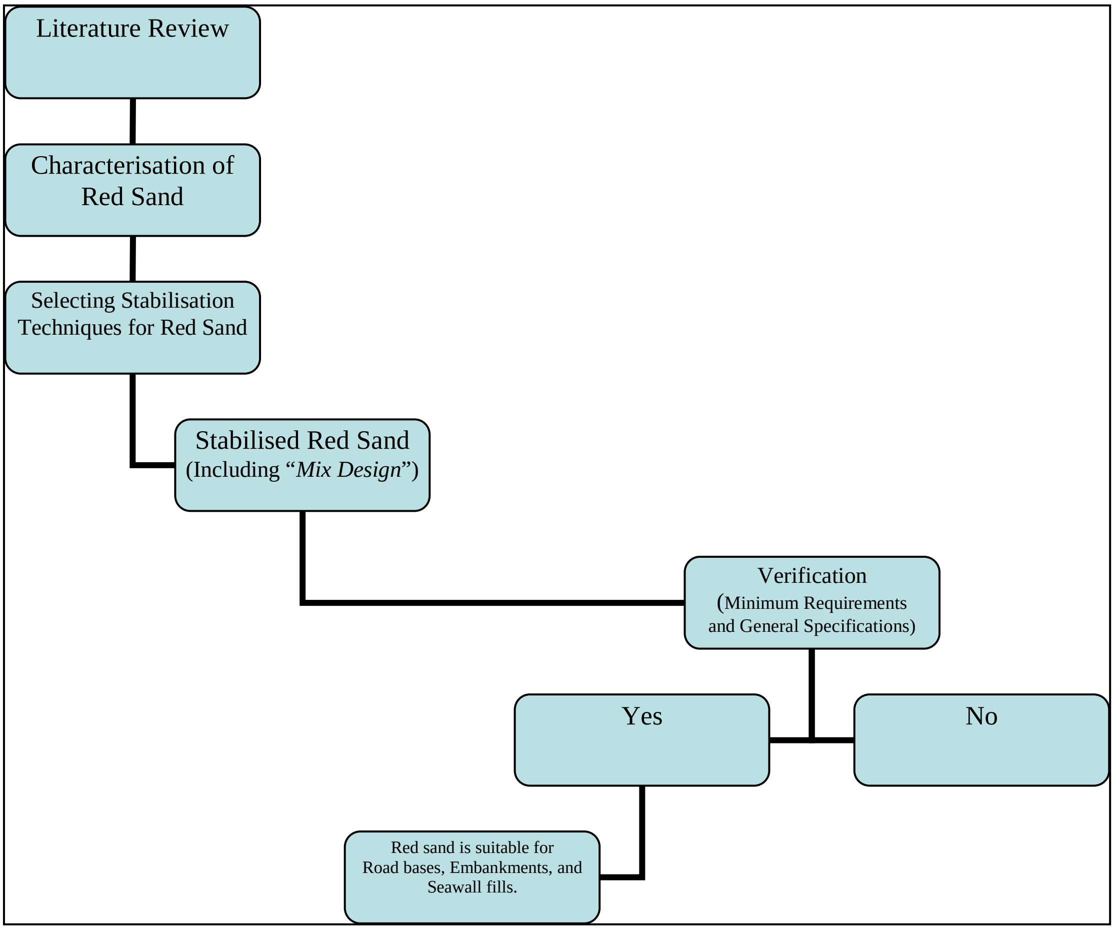

Figure 1.1 Methodology conclusion chart

Stabilisation of red sand

The third stage of this research is to examine stabilisation methods. From previous studies, red sand has tended to show the sand characteristics. It is important to improve its strength and durability before use as a construction material. The availability of stabilisation methods rests upon the basic properties of red sand; such as, gradation and consistency, and on factors affecting to its engineering properties, such as climate and regions. The stabilisation techniques selected will be appropriate with the specific properties of red sand and surrounding factors. In this stage, "*the mix design*" will be carried out to determine the best proportion of mixtures. Various admixtures and compaction techniques will be employed to improve red sand properties. Eventually, the possible stabilised red sand will be obtained in this stage.

Verification

The last stage of this research is the verification of stabilised red sand. Verifying this mixture will occur by comparing the mixture properties to the minimum requirement of the specific structure or the general specification of such structures. This mixture will be tested for its engineering properties. Tests for engineering properties include a triaxial test for various condition strengths, a resilient test for road design parameters, and compressibility test to evaluate the structure settlements.

1.5 Thesis outline

This thesis has six chapters, including the introduction chapter.

Chapter 1 consists of an introduction to the entire research study in general and highlights the objectives, scope, methodology and organisation of this study.

Chapter 2 reviews the generation of the main materials used (i.e. red sand and stabilisation mixtures). The physical characteristics, chemical, and engineering properties of the main materials are illustrated and an overview of fundamental knowledge of road bases, embankments, and seawalls, including the soil stabilisation technique to be used is presented.

Chapter 3 describes the experimental program followed, the testing materials, testing methods, and procedures.

Chapter 4 discusses and summarises the results of all tests undertaken in this research which included red sand characterisation, red sand for road bases, and red sand for seawall fills.

Chapter 5 addresses the application of the results of this study to the design and construction of road bases, embankments, and seawall fills. Design and construction aspects with relevant comments on those structures are introduced.

Chapter 6 presents the conclusion drawn from this study and makes recommendation for further research.

CHAPTER 2

BACKGROUND AND LITERATURE REVIEW

2.1 Alumina and red sand

2.1.1 Aluminium history

According to the documentation of the World Alumina Organisation (World Alumina Org: Alumina Refinery, 2000), the element of aluminium was first discovered in 1808 and 13 years later, bauxite ore was discovered. At that time, aluminium used to be refined in a tedious way which made it difficult to produce. It used to cost as much as gold due to its rarity and hence its industrial application was severely limited. It was only around 1885 (almost 80 years later) that a new refining process was discovered and opportunities opened for aluminium to be used for industrial purposes.

The Hall-Héroult process is the more refined method used to convert alumina to aluminium. Paul Louis Toussaint Héroult (France) and Charles Martin Hall (USA) simultaneously patented the refining process of aluminium in 1886. Although better aluminium refinery methods were discovered, they were still not ready for industrial application and alumina, the raw material from which aluminium is derived could not be processed in large quantities.

Table 2.1 Aluminium productions throughout the World since 2002(World Alumina Org: Alumina Refinery, 2000)

Period	Reported Primary Aluminium Production (Thousands of Metric Tons)							
	Area 1	Area 2	Area 3	Area 4/5	Area 6A	Area 6B	Area 7	Total
Year 2002	1,372	5,413	2,230	2,261	3,928	3,825	2,170	21,199
Year 2003	1,428	5,495	2,275	2,475	4,068	3,996	2,198	21,935
Year 2004	1,711	5,110	2,356	2,735	4,295	4,139	2,246	22,592
Year 2005	1,752	5,382	2,391	3,100	4,352	4,194	2,252	23,423

Area		Countries
Area 1	Africa	Cameroon, Egypt, Ghana, Mozambique, Nigeria, South Africa
Area 2	North America	Canada, United States of America
Area 3	Latin America	Argentina, Brazil, Mexico (1/1973-12/2003), Venezuela
Area 4	East Asia	China, Japan, North Korea, South Korea, Tadzhikistan
Area 5	South Asia	Azerbaijan, Bahrain, India, Indonesia, Iran, Turkey, United Arab Emirates
Area 6 A	West Europe	France, Germany, Greece, Iceland, Italy, Netherlands, Norway, Spain, Sweden, Switzerland, United Kingdom
Area 6 B	East/Central Europe	Bosnia and Herzegovina, Croatia, Hungary, Poland, Romania, Russian Federation, Serbia and Montenegro, Slovakia, Slovenia, Ukraine
Area 7	Oceania	Australia, New Zealand

Three years later, in 1889 Karl Josef Bayer discovered a process of refining bauxite ore for mass production, now used worldwide for alumina refinery known as the Bayer Process. This was a very important discovery as large quantities of alumina are required to produce aluminium; two tonnes of alumina per one tonne of Aluminium refined.

Australia is the largest producer of bauxite and alumina, with current mining sites such as Weipa in Queensland, Glove in the Northern Territory, the Darling Range in Western Australia and several other sites produce about 40% of the world's bauxite and over 30% of the world's alumina (Australian Atlas of Mineral Resources, 2006).

Since the recovery of Bayer process, aluminium has been used in a wide range of applications. Among its many advantageous properties, its toughness and resistance to atmospheric corrosion is probably the most outstanding. Its usage ranges from aluminium foils used in every household to aircraft parts and many other industrial applications.

2.1.2 Refining (the Bayer process)

Alumina combined with oxygen and hydrogen forms bauxite. The main minerals in bauxite are gibbsite ($Al_20_3.3H_20$), boehmite ($Al_20_3.H_20$), and diaspore.

The four stages of the Bayer process are described briefly in the following summary;

Digestion

Finely ground bauxite is first washed with a hot solution of caustic soda (NaOH) at 250°C. This converts the alumina into aluminium hydroxide, $Al(OH)_3$, which dissolves in the hydroxide solution according to the chemical equation 2.1

$$Al_2O_3 + 2\ OH^- + 3\ H_2O \rightarrow 2\ [Al(OH)_4]^- \qquad (2.1\ )$$

Clarification

Iron oxides and silica, which were part of the original bauxite, cannot dissolve in the alumina bearing solution (greenish liquor). Through filtration these by-products are removed (they are the red sand and red mud). The coarse sized particles are removed and washed to recover the caustic soda and the red mud is then separated out. The remaining greenish liquor is pumped through filters to remove any remaining impurities. The green liquor is then cooled from 1000°C to around 650°C to 790°C.

Precipitation

The hydroxide solution is allowed to cool and alumina hydrate is removed from the green liquor through a precipitation process, as white, fluffy solid.

Calcification

The solid alumina hydrate is heated to 1050°C to drive off the water of crystallisation, leaving alumina.

$$2\ Al\ (OH)_3 \rightarrow Al_2O_3 + 3\ H_2O \qquad (\ 2.2)$$

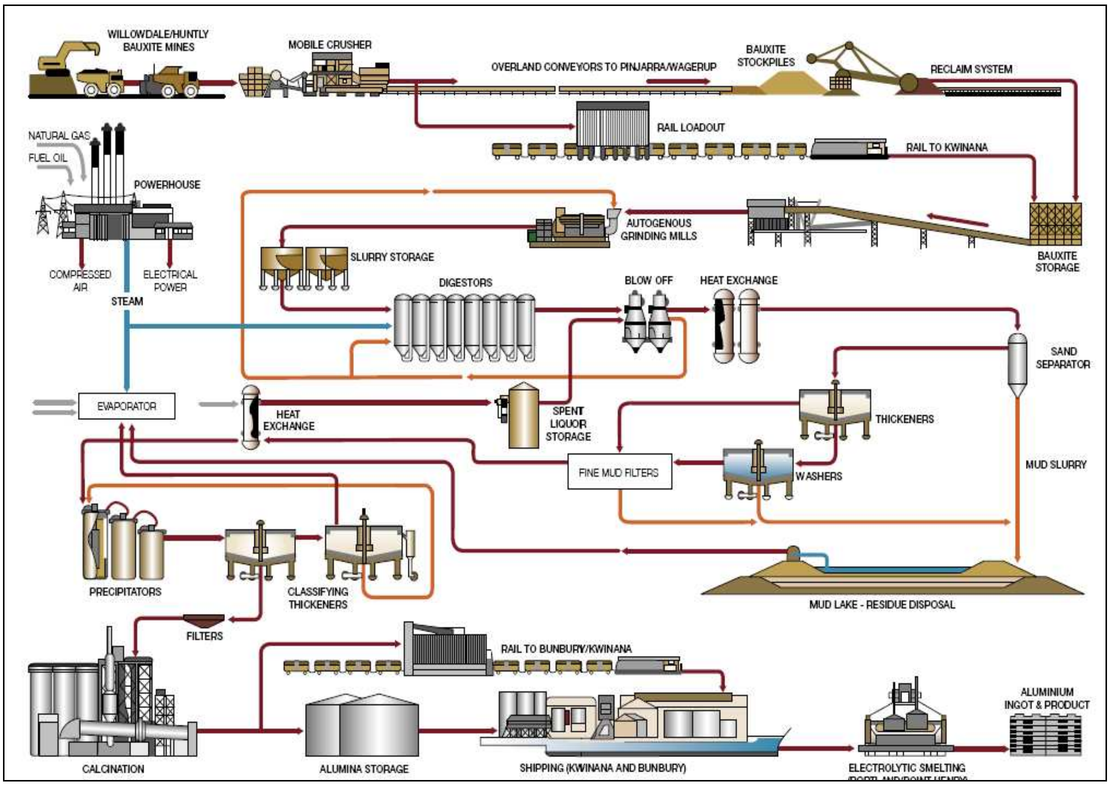

Figure 2.1 Bauxite to aluminium (Kwinana Alcoa, 2007)

The reaction with sodium hydroxide under heat and pressure also produces an alkaline coarse fraction named *red sand* whose its fractions are in excess of 90µm and the fine fraction named *red mud* or *Alkaloam,* has its fractions of less than 90 µm (Wah Yuni, 2005).

These are then separated into their individual class, washed to a lower pH before being disposed in a tailing dam. On average for every tonne of alumina refined, 2 tonnes of alumina is produced.

2.1.3 Red sand, red mud and red lime

Red sand, red mud (Alkaloam), and red lime are the three main by-products of alumina production. Red sand is the coarser fraction while red mud mostly consists of very fine particles in the silty fraction. Red lime is a different type of by-products which has similar properties as lime (high pH), except that it has a pinkish tint, making it an effective agent to neutralise acidic soils. Previous experimentation uses this substance in an attempt to reduce soil acidity.

Different refineries chooses various separation points for their own red sand and red mud, some prefer 90 microns whilst others prefer 100 microns. The sample used in this report donated by Alcoa Kwinana refinery which separates their red sand at 90 microns.

Red sand and red mud are treated in a different manner once they are separated. The Alkaloam needs to be de-watered over two stages, the first to drain the water from the red mud into the slurry stage, and the second to dry the red mud slurry in drying beds to reach a consistency so that earth moving equipment can work with it. The treatment involved with the various types of red sand will be covered in depth in the next section. Figure 2.2 shows red sand, red mud and red lime.

From Table 2.2 1996: Total Aluminium Mass Production Distribution in Australia, in 1996, a total of 1,754,000 tonnes of Aluminium was produced within a year, that means twice the amount of alumina is required and another twofold of red sand is produced. Recently, the booming Australian economy and a world material shortage definitely spell out an increase of demand and hence production of alumina and red sand.

Figure 2.2 Red mud, red sand and red lime

It is difficult to estimate the total volume of red sand produced per annum in Australia. However from Alcoa's three alumina refinery plants located in Western Australia, 20,000 tonnes of red sand and a similar tonnage of red mud is generated daily (Cooling & Jamieson, 2004).

Alcoa is currently researching the following fields to investigate the possibility of using by-products in the construction industry:

- The manufacturing of bricks (fired and non-fired).
- Road base, sub-base
- Fill material
- Embankment material
- Geopolymers in concrete
- Red sand and red mud as concrete aggregates

Among the potentials, utilisation for road bases and fill material uses the most quantity of red sand.

Table 2.2 1996: Total Aluminium Mass Production Distribution in Australia (Tamago Aluminium, 2006)

Company	Location	Tonnage Capacity
Boyne Island Smelters Pty Ltd (Comalco Consortia)	Gladstone (QLD)	490,000
Tomago Aluminium Company Pty Limited	Tomago (NSW)	440,000
Alcoa of Aust. Limited	Portland (VIC)	345,000
Alcoa of Aust. Limited	Point Henry (VIC)	185,000
VAW	Kurri Kurri (NSW)	170,000
Comalco Aluminium Limited	Bell Bay (TAS)	124,000
	Total Australia:	1,754,000

2.1.4 Environment Protection Authority (EPA) material utilisation requirement

The EPA has been established by the Parliament to monitor the Australian environment from all aspects. The EPA monitors pollution ranging from vehicles to farming, construction, marine, etc. In accordance with EPA's requirements, representative samples of the fill material have to be obtained and tested for composition to determine their suitability for fill material (see Table 2.3 Number of samples required for soil volume).

Table 2.3 Number of samples required for soil volume (Environment Protection Agency, 2007)

Soil volume (m3)	No. of samples	Soil volume (m3)	No. of samples
25 or <25	2	100	5
50	3	150	6
75	4	>150	1:25 or 95% UCL

Table 2.4 Maximum concentration of contaminants allowed in soil to be disposed of as fill materials (Environment Protection Agency, 2007)

Chemical	Maximum concentration (mg/kg)
Arsenic (As)	30
Cadmium (Cd)	5
Chromium (Cr)	250
Copper (Cu)	100
Cobalt (Co)	50
Lead (Pb)	300
Mercury (Hg)	2
Molybdenum (Mo)	40
Nickel Ni)	100
Tin (Sn)	50
Selenium (Se)	10
Zinc (Zn)	500
Cyanide (CN^-)	50
Fluoride (F^-)	450
Phenols (OH^-)	1

Representative samples are then tested and classified to check if the soil is suitable to be re-utilised or disposed of in accordance with EPA publication 448 Table 2 (Environment Protection Agency, 2007).

Table 2.4 shows the maximum concentration of possibly harmful substances. Chemical composition for industrial by-products such as the red sand have to be tested and registered in a Material Safety Data Sheet (MSDS), for workplace safety and regulatory compliance. Incidentally, this datasheet can be used to compare chemical composition of red sand against the EPA regulations.

2.1.5 Red sand treatment

- *Magnetic separator*

A magnetic separator is a commonly used device in the mining industry consisting of a non-magnetic conveyor belt and a magnet (electro magnet or earth magnet). There are various versions of magnetic separators to suit particle size, volume and machine efficiency, however all work on the same principle, using magnetism to separate ferric compounds.

Materials passing through the conveyor contain a mixture of ferrous and other compounds. When the magnet is activated, the ferrous compound will be attracted by the magnetism while the remaining material can be sieved out. Figure 2.3 shows a drum magnetic separator in which within the magnetic zone, ferric compounds are stuck to a rotating drum at which point non-magnetic materials drop off into a selected position. After exiting the magnetic zone, the ferric materials are collected.

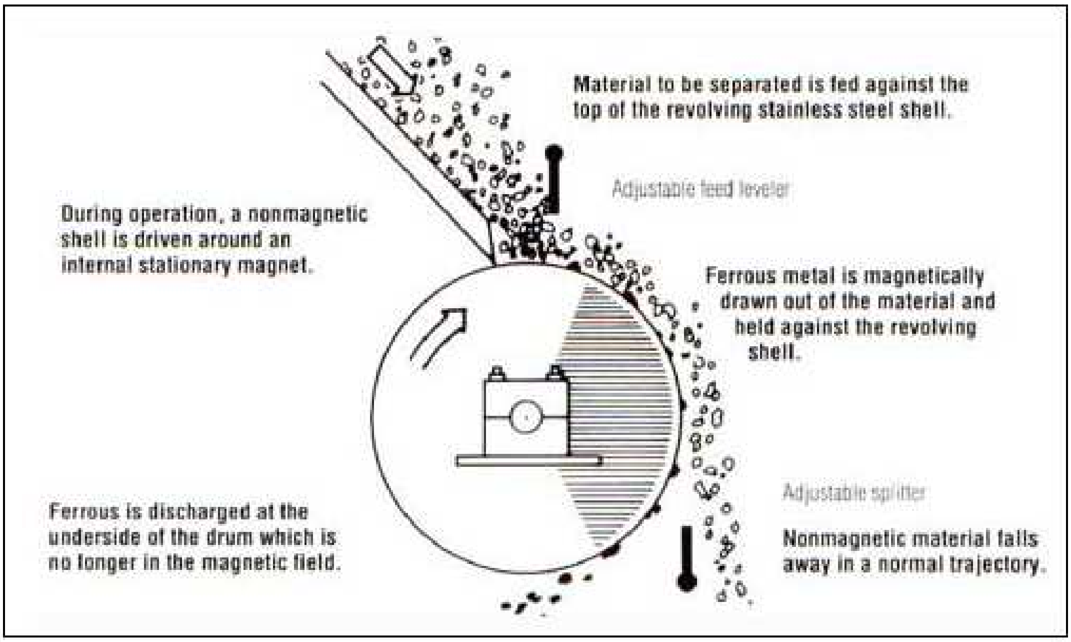

Figure 2.3 A drum magnetic separator (Steinert Struton-Gill magnetic, 2007)

- *Atmospheric carbonation*

Carbonation occurs naturally in the presence of carbon dioxide causing compounds to form carbonates, which are hard, granulated, and coarse and monolithic. The process is to simply leave the red sand in the open air to allow carbon dioxide abortion.

Carbonation is initially an experiment (Environmental Chemistry, 2006) conducted on red mud in an attempt to remove carbon dioxide in the atmosphere and at the same time, form coarser granular material in the red sand fraction.

Initial investigation indicates the potential of removing up to 15 million tonnes of carbon dioxide produced in Australia annually (Environmental Chemistry, 2006). There are three expected outcome:

- The red sand will form better gradation and show more material re-utilisation potential. Hence, working towards better sustainable resource management will be gained.

- A reduction in carbon dioxide (greenhouse gas) level in the atmosphere, effectively reducing the greenhouse effect will be attained.

- A reduction in the alkalinity of red sand due to the acidic nature of carbonates (acid and alkaline neutralises to form salt) will be obtained.

2.1.6 Variations in red sand

During the red sand and red mud separation process, approximately 10-15% of Alkaloam is retained in the red sand and the same percentage of coarse fraction in the red mud. At this point, the red sand is called *unprocessed red sand*.

The unprocessed red sand fractions are then left in the open for several years to be atmospherically carbonated. Washed and carbonated red sand is obtained by spraying the red sand stockpile regularly with clean bore water and CO_2 is sprayed to reduce its pH until it is less than 10.5. It can be predicted at this point that the washed and carbonated red sand would contain fewer fine particles and an increased coarse fraction due to the washing and carbonation process.

Red sand contains high amounts of iron oxide which gives the red tint in the material. It can be removed by using the magnetic separation process. This form of red sand is termed *high silica red sand* and the procedure is conducted so that higher silica content could increase the structural integrity of red sand.

Figure 2.4 High silica red sand, unprocessed red sand and washed and carbonated red sand

The intensity of the magnetism of the magnetic separator can be adjusted such that the content of the ferric oxide in the red sand varies. Depending on the magnetism, the red sand processed using this method can be classified into *high iron red sand*, *medium iron red sand*, and *high silica red sand*. High silica red sand has a lighter colouration in comparison to the unprocessed red sand and has been researched previously for similar concrete aggregate and road design purposes.

All forms of red sand samples extracted are left agitated in water for several hours to reduce acidity level from a pH of 11 - 13 to a more neutral level of 8.5 (Cooling & Jamieson, 2004).

2.1.7 Previous studies on red sand and other bauxite residues

- *The particle shape and texture of red sand*

Generally the suitability of granular materials for geotechnical applications is determined by particle size distribution. Granular material does not have cohesive or expansive properties which affect strength or require special treatment to be used. The particles have properties which can mostly be estimated by particle size, as better grading means an ability for them to be compacted, hence more strength.

Figure 2.5 Microscopy pictures of unprocessed red sand and natural Sand (Jitsangiam, 2007)

However, there are other factors to consider such as the particle shapes of the material. Figure 2.5 shows a comparison in particle shape between natural sand and red sand from the image magnified 50 times of the optical microscopy. It can be observed that the red sand is more angular than the natural sand. Theoretically, given both sands with same particle distribution, the particles of red sand should be able to interlock better than the natural sand, giving better strength.

This characteristic is more apparent in well graded granular materials. Poorly graded angular materials contain gaps which cannot be filled so that there are large numbers of air voids hence weakening strength properties.

- *Particle size distribution of red sand*

The following table 2.5 shows the preliminary particle size distribution testing and typical main roads specifications for sands. As can be observed, the red sand falls within main roads specifications.

- *The chemical properties of red sand*

Physical properties define the suitability of red sand usage in terms of strength and its chemical compositions can be seen in table 2.6 dictate the safety of the material for health and other purposes. An example is Alcoa's experimentation 1991 – 1996 using red mud for soil supplement application in farms around Yarloop received large public disapproval (Cooling & Jamieson, 2004). Farmers claimed the red mud was radioactive causing their livestock to fall ill and alleged it was causing elevations in heavy metal, arsenic and fluoride in the river system. With negative publicity, Alcoa decided to put this experiment on hold and is currently looking for an independent third party to re-evaluate the use of red mud.

Red sand obtained from different locations has varying properties, dependent on the original composition of bauxite. Jamaican bauxite mentioned in later section has high doses of radiation which limits the usage of red sand. Local test results suggested that Kwinana red sand has radiation levels within Western Australian regulations of 20 Mg/ha applied once every five years.

Table 2.5 Physical properties of red sand (Cooling & Jamieson, 2004)

	Red Sand		Typical main Roads specifications		
Sieve Size	Before	After	Fill	Subgrade	Drainage
Ret 37.5					
37.5					
26.5					
19					
13.2					
9.5					
4.75	100	100			
2.36	99	99	80 – 100	80 – 100	80 - 100
1.18	94	94	60 – 100	60 – 100	
0.6	73	75			
0.425	56	60	20 – 70	20 – 70	
0.3	41	46			
0.15	14	20			
0.075	5	8	0 – 20	5 – 15	1 (max)
0.0135	1	2	0 – 10	2 – 8	
Other tests					
Soaked CBR	53				
Un-soaked CBR	55				
Max. Dry Density	1.82				
Optimum	17.1				

Table 2.6 Chemical analysis of typical darling range bauxite (Cooling & Jamieson, 2004)

%	Bauxite	Red Sand	Red mud
Al_2O_3	38	7	17
Fe_2O_3	19	32	36
SiO_2	20	54	25
TiO_2	1.5	1.5	3.7
K_2O	0.25	0.05	0.7
Na_2O	<0.02	0.3	2.2
CaO	<0.02	0.1	3.5
MgO	0.15	0.1	0.5
P_2O_5	0.04	0.015	0.1
LOI	21	5	11

- *Sustainable use of residual bauxite tailings sand (red sand) in Concrete*

Wahyuni (2005) has investigated of red sand and fly ash as cement replacement. The following is his findings.

Six batches of concrete, one of which is kept as control, are cast. The components are as follows:

- Ordinary Portland cement + natural sand concrete (control)
- Concrete incorporating to red sand as a replacement of natural sand.
- Concrete incorporating red sand and 10% fly ash as cement replacement
- Concrete incorporating red sand and 15% fly ash as cement replacement

- Concrete incorporating red sand and 30% fly ash as cement replacement
- Ordinary Portland cement, natural sand and 10% fly ash as cement replacement

Furthermore, eight test parameters which included compressive strength, splitting tensile strength, flexural strength, modulus of elasticity, water permeability, chloride diffusion, water absorptivity, pH dependence leaching and scanning Electron Microscopy.

This experiment deals mostly with the variations in percentage of fly ash as cement replacement, 10% and 15% fly ash increase the strength of concrete while 30% fly ash decreases the strength. It was concluded that red sand does not significantly affect the strength of the concrete. The only major difference is that red sand leached chloride 60% higher than natural sand.

- *Red mud bricks in Jamaica*

Jamaica alumina industry produces approximately 12 million tonnes of red mud per annum. In 1997 an idea was suggested by Dr. Arun Wagh of the University of the West Indies, Dr. Carleton Davis of the Jamaican Bauxite Institute and Dr. J W Smith of the University of Toronto to turn red mud into safe, low cost bricks. Sodium celica are mixed into red mud, giving an exothermic reaction, it acts as glue between the red mud particles and it requires only to be heated in the sun, instead of normal kiln burning. Removal of the oven burning process would considerably decrease production cost. The report claimed that red mud bricks cost half as much as their kiln burned counterparts. Not only was it not cost efficient, but also a good way to dispose of tonnes of by-products per year. A full scale house was built after the completion of the research program, although further reinforcements are required for local hurricane conditions. The only concern is the slightly high radioactivity of Jamaican soil which causes the red mud bricks to emit radon emissions though it was concluded that these were within allowable limits.

- *Red Mud Jute Fibre Polymer Composite (RFPC)*

The aluminium industry in India is substantially large; an approximate 2,099,000 tonnes of alumina are produced each year, a very close production value to that of Australia.

Similar to Jamaica, India is a developing country where more people are within the poverty line. Not only does the use of RFPC reduce the quantity of industrial by-product, it is also cheaper in comparison to conventional wood panels; hence more economically viable for locals.

RFPC is a versatile composite which contains ferric oxide, alumina and titanium oxide from red mud and 82.5% cellulose and 11.3% lignin. RFPC is a wood panel replacement. The manufacturing processes are as follow:

- Fire retardency treatment of jute fibre.
- Grinding and sieving of red mud.
- Mixing of jute fibre, red mud and polymer in an appropriate ratio.
- Calandering of jute fibre cloth.
- Casting of the mixture.
- Curing of the mixture and demoulding.
- Quality testing of the final product.

Table 2.7 Indian Alumina production in 2001 (Maps of India, 2004)

Location	Production (tonnes per annum)	By-product (predicted, tonnes per annum)
Hindalco	476,000	714000
Balco	200,000	300000
Indal	442,000	663000
Nalco	931,000	1396500
Malco	50,000	75000
Total	2,099,000	3,148,500

The RFPC are environmentally friendly, are claimed to be three times stronger than wood, are weather-resistant and durable, corrosion-resistant, termite, fungus, rot- and rodent-resistant and fire-resistant. They have low production costs as the ingredients contain red mud. (Note: calandering is the process of pressing fabric between rollers or plates to smooth and glaze).

2.1.8 Possible geotechnical applications of red sand

- *Fill materials*

Fill materials ideally consist of soil material, however, aggregates, rocks and paving materials are also acceptable. Generally the coarser material will be placed at the very bottom of the fill to provide a stronger and more stable base and the top section of the fill consists of high quality sub-grade material which can be compacted to support the overlying pavement layers.

Granular soil are generally the most desired fill materials, as granular particles can be compacted, with the right moisture content, to an optimum dry density which gives the soil good strength characteristics. However, care has to be taken to ensure that the granular material is free of deleterious materials such as tree trunks, branches, etc.

Rocks for fill material have to be reasonable in size. While they are good to provide a sturdy base, they are relatively hard to work with. Rocks do not break down easily under machinery action and if sizes of individual rocks are too large, there will be too many gaps between the rocks.

- *Road materials*

Roads are classified into two main types, rigid and flexible pavements. In the state of Western Australia only, flexible pavements are used due to the cost versus population relationship; rigid pavements are stronger and more durable however, they are extremely costly. The most commonly used pavement materials in Australia are naturally occurring aggregates, however, these are few and hard to come by hence aggregates are manufactured by crushing rock base and limestone.

- *Embankments*

Embankments are fill structures designed to hold a load or to elevate an existing grade of roadway (or railway). They can be used in various applications, bridge embankment, a method to contain water, a retaining wall to prevent soil erosion and many others. In general embankments are approximately 4.5m in height and are trapezoidal in shape to allow for load distribution. The slope of embankment is a critical design factor; the steeper the slope means that the base width will be smaller; less fill material required thus reducing construction costs. However, the maximum angle is limited by the materials angle of internal friction. The majority of materials used to construct embankments are rocks and soil. There are three major forms of failure.

General shear failure is formed when the base soil is over consolidated and its shear capacity is breached. As a result, the embankment tilts and eventually collapse to one side. This mode of failure is sudden (Whitlow, 2001).

Consolidation failure occurs when the embankment is built on a compressible foundation layer which allows differential settlement. This mode of failure usually takes longer to develop (Whitlow, 2001).

Punching shear occurs when the embankment slope is too steep causing insufficient load distribution to the foundation. As the embankment is loaded, the load is carried vertically into the ground (Whitlow, 2001).

As can be noted from these failure modes, all involve some form of shear; hence shear characteristics are important for embankment designs.

2.2 Soil stabilisation

2.2.1 Stabilisation materials

This section focuses on a description of industrial by- products being utilised in this project, red sand, lime kiln dust, and fly ash.

- *Alcoa red sand*

Alcoa is the world's leading alumina producer and has alumina refineries throughout the world. The refinery in Kwinana, Western Australia is the location from which red sand for this project was sourced, thus its properties will be looked at in more detail as they vary with the type and grade of bauxite ore used.

The bauxite which is processed at the Kwinana refinery comes from the Huntly mine in the Darling Range of Western Australia and is the lowest grade of ore mined on a commercial scale anywhere in the world (DEH, 2006). At the Kwinana refinery, the production of a tonne of alumina produces 1.1 – 6.0 tonnes of bauxite residue (Happel et al., 200).This rate is three times the normal rate, indicating the Kwinana refinery produces vast amounts of red sand.

There is currently no solution to the growing problem at Kwinana of the disposal of this bauxite residue and although this is an international issue which Alumina refineries world-wide must deal with, the problem is more significant in industrialized countries such as Australia, due to the ever increasing value of land in the metropolitan areas. At the proposed rate of expansion for Alcoa's three Western Australian refineries at Kwinana, Pinjarra and Wagerup, the residue ponds may cover 6000 ha within 70 years (Cooling & Jamieson, 2004).

Another important issue with stock-piling of bauxite residue is the environmental problems caused by the highly alkaline nature of the industrial by- product. Alcoa red sand is considered non-toxic but it is, however, highly alkaline, due to the sodium hydroxide used in the Bayer process. Sodium hydroxide is a highly alkaline base, and in concentrated form is extremely dangerous. It is the presence of this sodium hydroxide which gives the bauxite residue its high pH, generally between 11 and 13.

Because of the high alkalinity of the bauxite residue, Alcoa has implemented steps to dispose of this industrial by-product in an environmentally safe manner. The main issue with the disposal of a material with a high pH is seepage of the alkaline material into the watercourse and uptake by vegetation in the surrounding areas if the material is allowed to leach into the surrounding soil. Therefore, the bauxite residue is, washed and filtered to remove as much of the caustic soda (sodium hydroxide) as possible, to try and limit the pH of the bauxite residue. The bauxite residue is then stock piled in retention ponds where it is left for several years. These ponds are constructed such that they act as contained systems, with a layer of clay being used to seal the walls and base to contain the caustic liquor, and minimise leaching.

Once each disposal area is full of residue, it is left to dry and consolidate. As the stockpiles are open to the atmosphere, the bauxite residue is atmospherically carbonated to neutralise the high alkalinity of the material. Over time, the pH of the residue is lowered, and these retention ponds are then able to be revegetated, thus the process of disposal can occur with minimal impact on the environment. It is, however, a very expensive and time consuming process to dispose of the material in an environmentally safe manner and thus it would be of great benefit to Alcoa and the alumina industry if this bauxite residue could become a marketable commodity.

Testing was conducted on the Alcoa red sand by Jitsangiam (2007), to determine the basic geotechnical properties of the red sand to give an initial indication of its suitability for use as a road base material. The basic properties which were evaluated included specific gravity, Atterberg limits, compaction characteristics, CBR values, water conductivity, and shear strength. The results of these investigations are given in table 2.8 below.

Table 2.8 Basic geotechnical properties of Alcoa red sand (Jitsangiam, 2007)

<table>
<tr><td>Properties</td><td colspan="4">Values</td></tr>
<tr><td>Specific gravity</td><td colspan="4">3.03</td></tr>
<tr><td>Atterberg limit</td><td colspan="4">Non- Plasticity</td></tr>
<tr><td rowspan="3">Compaction</td><td colspan="2">Modified</td><td colspan="2">Standard</td></tr>
<tr><td>MDD(t/m^3)</td><td>OMC (%)</td><td>MDD(t/m^3)</td><td>OMC (%)</td></tr>
<tr><td>1.83</td><td>17.6</td><td>1.60</td><td>20.2</td></tr>
<tr><td rowspan="3">CBR</td><td colspan="2">Modified</td><td colspan="2">Standard</td></tr>
<tr><td>Soaked (%)</td><td>Unsoaked (%)</td><td colspan="2" rowspan="2">-</td></tr>
<tr><td>55</td><td>48</td></tr>
<tr><td rowspan="3">Water Conductivity</td><td colspan="4">Coefficient of Permeability (cm/sec)</td></tr>
<tr><td colspan="2">Void Ratio, e = 0.65</td><td colspan="2">Void Ratio, e = 0.89</td></tr>
<tr><td colspan="2">1.54×10^{-4}</td><td colspan="2">6.93×10^{-4}</td></tr>
<tr><td rowspan="4">Shear Strength</td><td colspan="4">Friction Angles, ø (˚)</td></tr>
<tr><td colspan="2">Void Ratio, e = 0..65</td><td colspan="2">Void Ratio, e = 0.89</td></tr>
<tr><td>At Ultimate Strength</td><td>At Peak Strength</td><td>At Ultimate Strength</td><td>At Peak Strength</td></tr>
<tr><td>40.03</td><td>45.00</td><td>37.48</td><td>40.56</td></tr>
</table>

From these initial investigations (Jitsangiam, 2007), it was concluded that red sand is a potentially useful source for construction materials, in particular for geotechnical engineering work. Based on the geotechnical properties alone, red sand would appear to be a good fill material. Its particle appearance has high angularity which is a good characteristic for such material because high shear resistance is appropriate from a geotechnical engineering perspective (Jitsangiam, 2007).

The consistency of Alcoa red sand containing alumina, titanium, sodium, silicon and ferric oxide compounds among others with their relative proportions is shown in table 2.9.

Table 2.9 Bauxite residue composition (Alcoa Australia, 2006)

Chemical Compound	% Composition		
	Bauxite	Red Sand	Red Mud
Alumina (Al_2O_3)	38	7	17
Ferric Oxide (Fe_2O_3)	19	32	36
Silicon Dioxide (SiO_2)	20	54	25
Titanium Dioxide (TiO_2)	1.5	1.5	3.7
Potassium Oxide (K_2O)	0.25	0.05	0.7
Sodium Oxide (Na_2O)	<0.02	0.3	2.2
Calcium Oxide (CaO)	<0.02	0.1	3.5
Magnesium Oxide (MgO)	0.15	0.1	0.5
Phosphorous Pentoxide (P_2O_3)	0.04	0.015	0.1
Loss of Ignition	21	5	11

- *Collie fly ash*

Fly ash, also known as CCP (Coal Combustion Product) is a mineral residue produced from the combustion of coal in electric generating plants. Ash is a constituent of the incombustible portion of the coal and thus upon the combustion of the coal, the ash is left as it is incombustible. Coal can range in ash content from 2% - 30%, and of this around 85% becomes fly ash, the remaining 15% being known as bottom ash (Hendrich, 2003) .Four types of CCP are produced from the combustion of coal, fly ash, bottom ash, and boiler slag and flue gas desulphurization a by-product material.

There are two electrical power plants in Western Australia fuelled by coal in Collie and Muja. Western Power's power station in Collie is the location from which the fly ash used in this investigation was sourced. The Collie Power station generates approximately 70,000 tonnes of fly ash and 15,000 tonnes of bottom ash annually (ETC, 2003) so there are significant amounts of these industrial by products being produced.

The fly ash particles solidify while suspended in the exhaust gases and are thus generally spherical in shape, the finer air borne particles; consequently they are very small, ranging from 0.5 µm to 100 µm. Bottom ash, the other main component generally has larger particles which are not able to be lifted by the flu gases, consequently these denser particles fall to the bottom of the furnace where they can be collected.

Fly ash particles generally contain silicon dioxide (SiO_2), aluminium oxide (Al_2O_3) and iron oxide (Fe_2O_3), which are known as pozzolans. These pozzolans form a cementious material (gel) by reacting with lime in the presence of water, a reaction which is known as the hydration of fly ash. This cementious material is able to bind inert materials together, meaning that they are able to be stabilised through the hydration of fly ash. Soil stabilisation, which is the primary focus of this project, relies on these pozzolanic properties of fly ash to stabilise the red sand and improve its geotechnical properties.

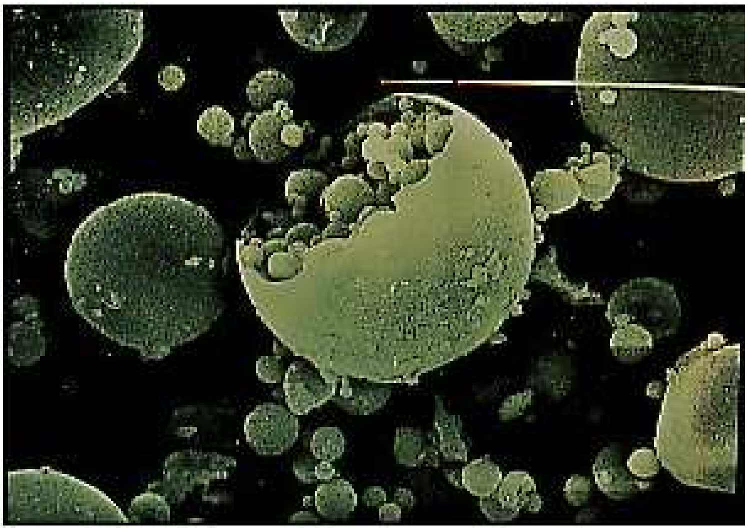

Figure 2.6 Spherical fly ash particles (We Energies, 2003)

The pozzolanic reactions for the generation of the cementious gel responsible for soil stabilisation are as follows:

$$\underset{\text{(Lime)}}{CaO} + \underset{\text{(Water)}}{H_2O} \rightarrow Ca(OH)_2 \qquad (2.5)$$

$$Ca(OH)_2 \rightarrow Ca^{2+} + 2(OH)^- \qquad (2.6)$$

$$Ca^{2+} + 2(OH)^- + \underset{\text{(Pozzolan)}}{SiO_2} \rightarrow \underset{\text{(Gel)}}{CSH} \qquad (2.7)$$

$$Ca^{2+} + 2(OH)^{-} + \underset{\text{(Pozzolan)}}{Al_2O_3} \rightarrow \underset{\text{(Gel)}}{CAH} \qquad (2.8)$$

It is the CSH and CAH gels that provide the cementious material which binds the soil and thus helps to improve the engineering properties of the soil.

Table 2.10 Fly ash composition (Cockburn cement, 2006a)

Compound	Percentage Composition (%)
SiO_2	53.7
Al_2O_3	34.7
Fe_2O_3	7.6
CaO	0.18
MgO	0.37
TiO_2	1.81
Na_2O	0.46
K_2O	0.63
P_2O_5	0.04
Mn_3O_4	0.12
SO_3	0.009

There are two main classes of fly ash:

i. Class F – Normally produced from the burning of anthracite of bituminous coal. Class F fly ash has pozzolanic properties.

ii. Class C – Normally produced from the burning of lignite or sub-bituminous coal. Class C fly ash has pozzolanic properties as well as some cementious properties.

Class F fly ash, the most commonly produced fly ash in Australia (Hendrich, 2003) was used for this investigation. It consists mainly of siliceous and aluminous materials thus it lacks cementious properties. As a result, Class F fly ash requires the addition of an activator. A common activator is lime, as the lime reacts with the pozzolanic materials in the fly ash to create cementation, thus allowing the formation of the cementious gel responsible for the modification of the engineering properties of the soil.

Class C fly ash is considered as self-cementing as it contains considerable quantities of lime, more than 10% in some cases (Arora & Aydilek, 2005).The lime is able to react with the pozzolanic materials present in the fly ash with the addition of water to provide it with self cementing properties. Class F fly ash also contains lime but in insufficient quantities to enable activation of the pozzolanic materials within the fly ash.

- *Lime kiln dust*

As Class F fly ash was selected for this project sourced from Cockburn Cement in Western Australia, it could not undergo self- cementation, consequently lime was added as an activator.

Lime kiln dust (LKD) is a waste product from the production of lime and can vary chemically depending on whether high-calcium lime (chemical lime, hydrated lime, quicklime) or dolomitic lime is being manufactured. LKD is obtained through dust collected by the electrostatic precipitators in the lime kiln stacks during the lime production process (Cockburn cement, 2006a). LKD obtained during the manufacture of quicklime is of particular importance as it is possible to use this as a direct replacement or substitute for hydrated lime.

Figure 2.7 Lime kiln dust

Lime kiln dust can be divided into two main categories based on the relative reactivity of the dust. These are related to the amounts of free lime and free magnesia in the LKD, the proportions of these components being dependant on whether the feedstock employed is calcitic or dolomitic limestone. LKD with a high amount of free lime is highly reactive upon the addition of water is of the greatest interest for commercial purposes.

As can be seen in table 2.11, LKD is composed primarily of calcium oxide (CaO) and calcium carbonate ($CaCO_3$).

Table 2.11 Lime kiln dust composition (Cockburn cement, 2006a)

Compound	**Percentage %**
CaO	63.1
$CaCO_3$	22.9
MgO	4.6
$MgCO_3$	4.1
Na_2O	1.7
SO_3	1.2
Cl	0.6
Fe_2O_3	0.5
K_2O	0.5
SiO_2	0.2
Al_2O_3	0.1

The lime kiln dust used in this investigation also has a loss of ignition of 30.6% as well as an available lime (CaO) content of 27.4% (Cockburn cement, 2006a).

2.2.2 Soil stabilisation techniques

This section presents possible soil stabilisation techniques for red sand. Construction material must satisfy a number of requirements and the properties of red sand may be improved to meet these factors. Some soil stabilisation techniques which would be possible for red sand are described.

- *Granular stabilisation*

The engineering properties of red sand can be improved by mixing it with different materials of different grades to give the red sand a broader particle size distribution, thus internal friction would be increased as a more favourable gradation caused by granular stabilisation would reduce a number of voids in the soil. This technique would considerably increase the strength of the material, material strength is obtained from the mechanical interlock of particles (Roach, 1992).

Although granular stabilisation is a relatively inexpensive form of soil stabilisation, the process is quite tedious and difficult to achieve. It is also unlikely that granular stabilisation would give the red sand the strength characteristics required for use as a basecourse material.

- *Lime stabilisation*

Lime stabilisation involves the blending of lime with the material. A common source of lime used for this in Western Australia is lime kiln dust which contain approximately 20% free lime (Cockburn cement, 2006a). This form of stabilisation is predominately used for clays, as the addition of lime enables cementious materials to be formed as the lime reacts with pozzolans (SiO_2, Al_2O_3, and Fe_2O_3) present in the soil. The structure of clay is a series of sheets which are bonded together and pozzolanic activity breaks this bond between the sheets changing the material into a granular type material. This form of stabilisation enhances both the strength and workability of the clay.

This method is not really suitable for stabilising Alcoa red sand as it does not contain sufficient pozzolans to enable cementation and a pozzolanic material, therefore such as fly ash, would have to be added to the soil for cementation to occur.

- *Fly ash stabilisation*

This is another form of pozzolanic stabilisation in which fly ash is added to the soil. Class C fly ash, when in the presence of water, can react to form a cementious gel because Class C fly ash contains pozzolans as well as lime and thus can be used to stabilise inert materials which do not contain appreciable quantities of pozzolans.

This could be possible means of stabilising Alcoa's red sand; however, Class C fly ash is not as readily available as Class F fly ash in Western Australia, so it would be more economically viable to use Class F fly ash for stabilisation.

- *Lime – fly ash stabilisation*

Lime-fly ash stabilisation it has been observed in previous research is well-suited for stabilising silty and sandy soils (Arora & Aydilek, 2005) indicating its suitability for red sand.

Lime - fly ash stabilisation is a means of soil stabilisation which can be applied when Class F fly ash is being utilised as the stabilising agent. Because Class F fly ash does not contain high enough levels of lime to enable self-cementation, lime can be added to allow for the activation of the pozzolans in the fly ash, in the presence of water.

This is the method of stabilisation which was used to enable the improvement of the engineering properties of the red sand in this investigation, as the red sand is a sandy soil, and Class F fly ash is readily available in Western Australia.

2.2.3 Use of stabilisation

The Austroads Pavement Design Handbook (Austroads, 2004) states that where suitable, and expertise is available, stabilisation can be used to:

- Increase the strength and improve uniformity of subgrades and pavement material
- Optimize the use of available pavement materials
- Reduce layer thickness

Austroads (2004) considers that lime-fly ash stabilised materials are classified as cemented materials and also points out that one of the unavoidable problems with cemented materials is the development of shrinkage cracks. The major problem with cracks is they have the potential to propagate to the surface of the pavement, providing a pathway for the infiltration of moisture. This is an issue as the moisture can lead to a debonding of the layers within the pavement and/or weakening of the granular layers. There are several factors which influence the severity of cracking including binder type, material type, initial moisture content and curing conditions.

Often asphalt or granular material is placed over cemented materials to minimize reflection cracking. If cracks do reflect through to the surface, cracks can be sealed to prevent moisture infiltrating into the cemented soil. The effectiveness of crack sealing methods is however highly dependent on the width of the crack.

The susceptibility of the red sand used in this investigation to shrinkage cracking shall be limited by the level of cementation tolerated in the samples. The level of cementation occurring in the stabilised material was controlled through limiting the 7 day UCS value of the stabilised material to less than 1 MPa. By limiting the acceptable UCS values, the susceptibility of the material to developing tensile strains and cracking is limited.

2.2.4 Previous studies on stabilisation

This literature review will focus on previous work conducted using fly ash to stabilise soils, as well as investigations conducted on using stabilised red sand as a construction material.

- *Use of class C fly ash for stabilisation of soft subgrade*

Studies were undertaken by Senol et al. (2002) to investigate the stabilising effects of self cementing Class C fly ash on a soft subgrade, a low plasticity clay from Wisconsin USA.

The soil was subjected to a series of laboratory tests, including an unconfined compression strength (UCS) test, California Bearing Ratio (CBR) and resilient modulus tests so that the engineering properties of the stabilised soil could be compared to untreated soil, to determine the effect of the addition of fly ash.

UCS tests were conducted on samples with varying proportions of fly ash. There were also samples which were compacted two hours after the addition of the water, to simulate the compaction delays that typically occur in the field. The results of the UCS tests are shown in figure 2.8 below.

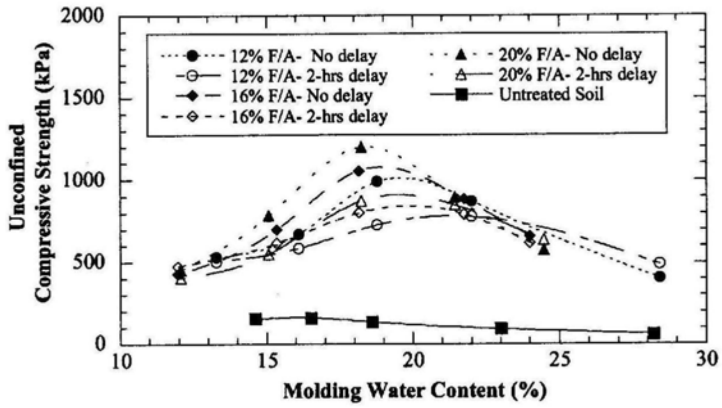

Figure 2.8 UCS values for varying fly ash content (Senol, Bin-Shafique, Edil, & Benson, 2002)

The results show that fly ash increases the strength of the soil significantly over the untreated sample. There is also a trend that the strength of the samples increases as the fly ash content increases. The results also show that maximum strength is reduced by about 20% due to the compaction delay, indicating it has significant effects on the material's performance.

CBR tests were performed on 3 samples with varying fly ash content to determine the effect of fly ash stabilisation on the soil strength. Higher CBR values indicate a soil with greater load bearing capacity. There were also samples which had two hour delays between the addition of water and compaction to assess the impact this had on the soils strength. The results of the CBR test are shown in figure 2.9 below.

These tests results indicate that the strength of the soil increases as the fly ash content increases as there is a trend for the CBR to increase as the fly ash content increases. These results support the results of the UCS tests that the soil's strength increases with increased fly ash content. It can also be seen that there is a drastic difference between the CBR of the untreated soil and soils which had fly ash added, as the untreated soil obtained a CBR value of 1%, with stabilised specimens obtaining CBR values as high as 60%.

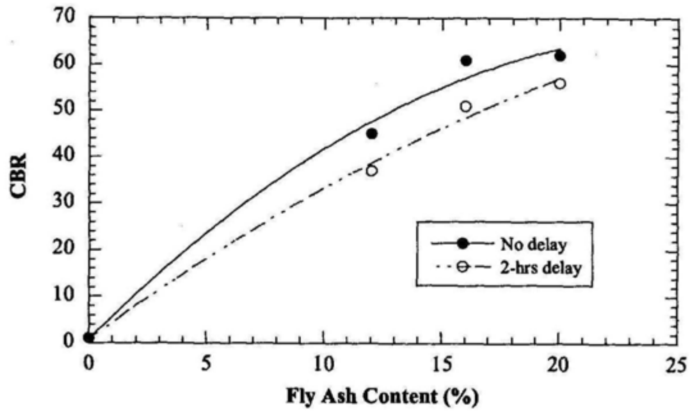

Figure 2.9 CBR values for varying fly ash content (Senol et al., 2002)

The resilient modulus is a measurement of the soil response when subjected to repeated loading and is one of the most important characteristic of subgrades used in pavement design (Senol et al., 2002)

Resilient modulus tests were conducted on three samples with varying fly ash content and a water content relating to the optimum moisture content found in the UCS tests.

The results of the tests are shown in figure 2.10.

The results show that there is an increase in resilient modulus as the fly ash content increases. It was claimed that the untreated sample continuously failed during testing consequently there is no test data for the untreated sample.

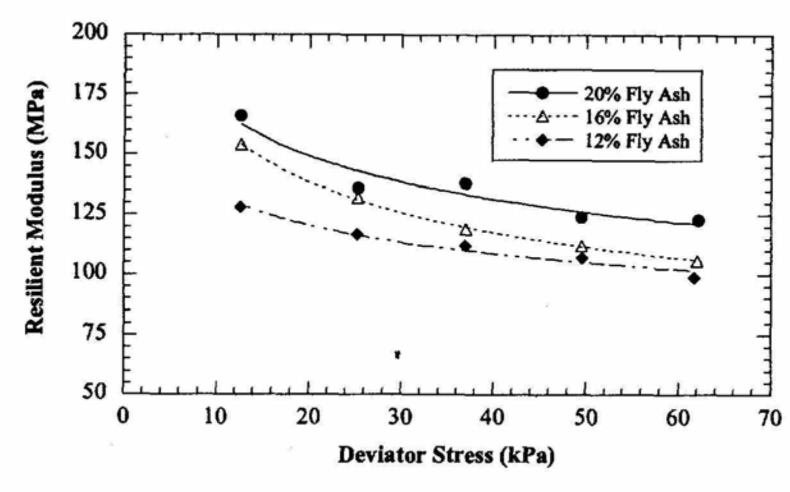

Figure 2.10 Resilient modulus values for varying fly ash content (Senol et al., 2002)

The results of the investigation show that there can be significant improvements in the engineering properties of a clay material with the addition of fly ash and that Class C fly ash could be used, without any other activator, to successfully stabilise the soil.

- *Class F fly-ash-amended soils as highway base material*

An investigation was conducted by Arora and Ayldilek (2005) into the use of Class F fly ash stabilised soils, with cement or lime as activators, as a base layer in highways.

It included UCS tests, as well as CBR and resilient modulus tests, to assess the engineering properties of the amended soil. The laboratory tests were specifically aimed at noting the effect of fines content, curing time, moulding water content, activator types and soil cohesion on the engineering properties of the soil.

The soil used for the tests was classified as a light brown silty sand (SM) and fly ash was low calcium Class F fly ash, obtained from the Indian River Power Plant. The two activators were Type I Portland Cement, and high calcium (95%) quicklime.

In order to test the effects of varying fines content, they were varied from 6%-30% by weight. The effect of curing periods on the UCS were investigated by testing samples with curing periods of 1, 7, 28, 56, and 90 days. To test the effects of moulding water content, the specimens were compacted at optimum water content, 4% wet of optimum and 4% dry of optimum and the strength parameters of these different samples were observed. There were two different activators, namely cement and lime, to access the impact of the activator type on the strength parameters. To test the effects of fines content, kaolinite was added at 10% of the total weight of some mixtures allowing the effect of cohesive clay particles on the strength parameters to be investigated.

Table 2.12 gives a summary of the different mixtures which were used.

In order to assure quality control, triplicate samples were tested, the average results being used as the basis of any conclusion. It is claimed that the standard deviation of the triplicate tests results was less than 8% in all cases, suggesting that the level of accuracy is quite high.

For the UCS, the effects of fines content, moulding water content, curing period, cement content and effect of activator type were investigated.

Table 2.12 Summary of trialled mix proportions (Arora & Aydilek, 2005)

Specimen name	Soil (%)	Cohesionless fines (% of soil)	Fly ash (%)	Cement (%)	Lime (%)	Kaolinite (%)	Compactive effort	Water content during compaction (%)	γ_{dm}[a] (kN/m^3)	Optimum moisture content (OMC) (%)
FA1-C7	60	6	40	7	—	—	Standard	OMC	15.88	16.8
FA1-C7+4	60	6	40	7	—	—	Standard	OMC+4	—	—
FA1-C7−4	60	6	40	7	—	—	Standard	OMC−4	—	—
FA3-C7	60	18	40	7	—	—	Standard	OMC	15.46	18.1
FA3-C7+4	60	18	40	7	—	—	Standard	OMC+4	—	—
FA3-C7−4	60	18	40	7	—	—	Standard	OMC−4	—	—
FA5-C7	60	30	40	7	—	—	Standard	OMC	15.34	17.7
FA5-C7+4	60	30	40	7	—	—	Standard	OMC+4	—	—
FA5-C7−4	60	30	40	7	—	—	Standard	OMC−4	—	—
FA3K-C7	50	18	40	7	—	10	Standard	OMC	15.88	16.7
FA3K-C7+4	50	18	40	7	—	10	Standard	OMC+4	—	—
FA3K-C7−4	50	18	40	7	—	10	Standard	OMC−4	—	—
FA3-C1	60	18	40	1	—	—	Standard	OMC	15.45	16.5
FA3-C2	60	18	40	2	—	—	Standard	OMC	15.5	17.5
FA3-C4	60	18	40	4	—	—	Standard	OMC	15.46	17.2
FA3-C5	60	18	40	5	—	—	Standard	OMC	15.39	17.2
FA3-L4	60	18	40	—	4	—	Standard	OMC	15.47	17.7
FA3-L7	60	18	40	—	7	—	Standard	OMC	15.36	17.7
FA3-L10	60	18	40	—	10	—	Standard	OMC	15.03	18.2
FA3K-L7	50	18	40	—	7	10	Standard	OMC	15.45	16.8
FA1-C7–M	60	6	40	7	—	—	Modified	OMC	16.92	13.4
FA3-C7–M	60	18	40	7	—	—	Modified	OMC	17.15	13.2
FA5-C7–M	60	30	40	7	—	—	Modified	OMC	17.16	13.0

Note: 100% mixture of soil and fly ash is considered as base, and cement or lime was added at a certain percentage by weight of this base mixture.
[a]γ_{dm}=maximum dry weight.

The UCS for the varying fines content and moulding water content are shown in figure 2.11.

The mixtures FA1, FA3 and FA5 have percentages of fines by weight of 6, 18 and 30% respectively.

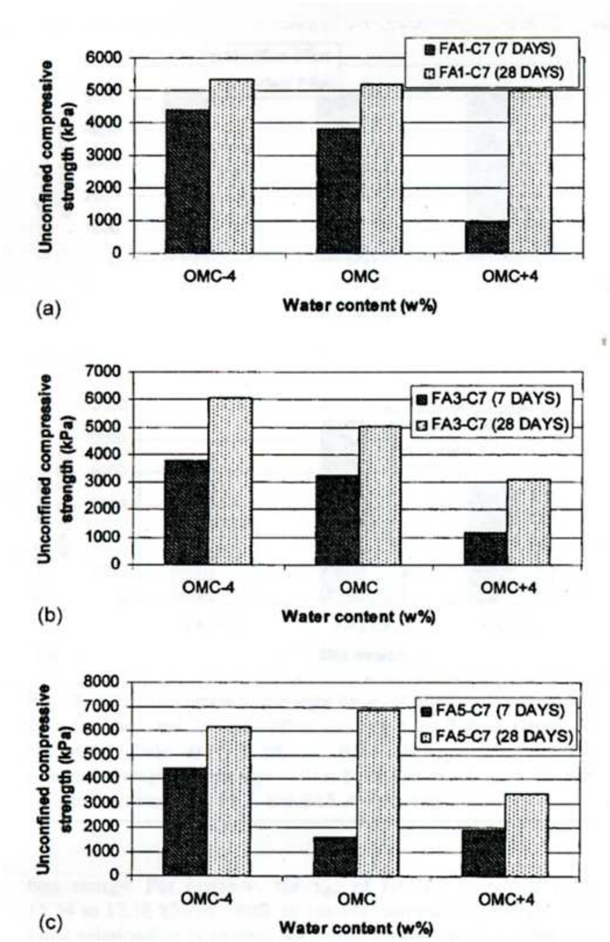

Figure 2.11 UCS values for varying fines contents and moulding water contents (Arora & Aydilek, 2005)

A consistent trend cannot be observed between the UCS and the fines content for the 7 day test results as it is believed that the specimen did not fully hydrate after 7 days. There was however a trend visible for the 28 day cured specimen where strength increased with increasing fines content, with the exception of the FA1 sample compacted at 4% wet of the OMC. However, the trends between the fines content and UCS, although apparent, are not very conclusive.

The trend between the moulding water content and the UCS indicate that the UCS decreases with an increased water content. This can be attributed to the fact that cement was used as the activator and very high water content (W/C) ratios leave ‘bleed water’, water that appears as standing water on the surface of the mass. It is believed that this occurs at a W/C ratio greater than 0.4 and the W/C ratio for the samples in this test were greater than 0.4, even for those compacted at optimum moisture content.

The effects of varying curing time on the UCS can be shown in figure 2.12.

The specimens used to test the effects of varying curing periods were mixtures FA1, FA3 and FA5, which have percentages of fines by weight of 6, 18 and 30% respectively. Samples were also tested at OMC, 4% wet of OMC and 4% dry of OMC.

All the specimens tested invariably showed a similar trend of strength increase with an increased curing period.

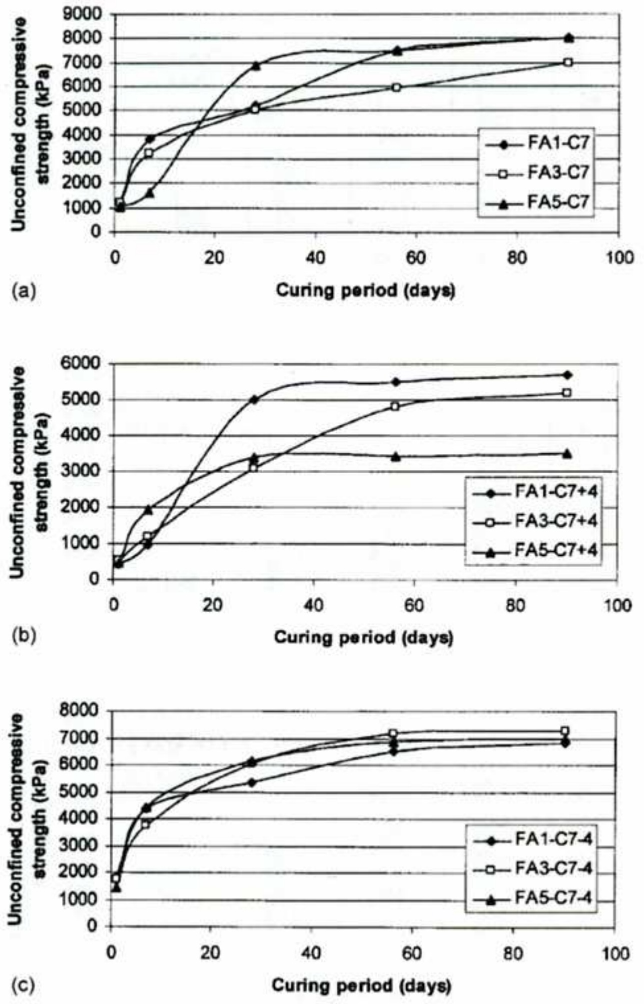

Figure 2.12 UCS values for varying curing periods(Arora & Aydilek, 2005)

It was also evident that the rate of strength increase is higher in the initial stages and that it does not significantly increase after 56 days. It is greatest at 90 days and there seems to be no significant increase after this period

The results of the UCS tests are shown in the figure 2.13.

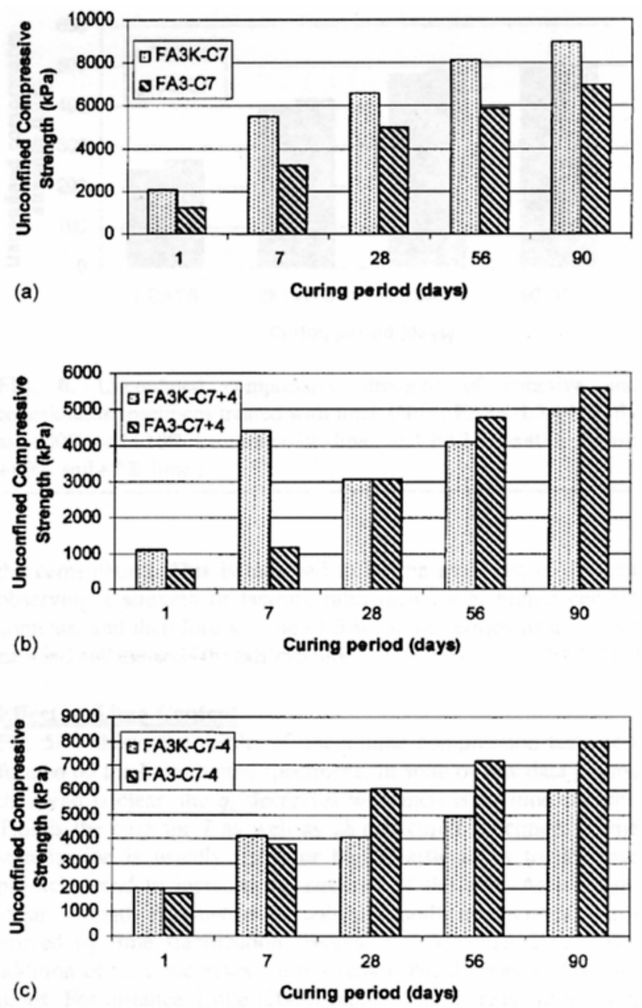

Figure 2.13 UCS values for varying curing periods(Arora & Aydilek, 2005)

The results show a comparison between FA3-C7, a sample with cohesionless fines, and FA3K-C7, the sample containing the kaolinite. The strength is higher for the sample containing the cohesive fines (FA3K-C7) than the sample with the cohesionless fines (FA3-C7) for samples compacted at OMC. However, these trends are not apparent for samples compacted 4% wet and 4% dry of OMC. These trends can be attributed to the differential effect of cohesive fines. It is generally accepted that cement stabilisation is effective for mixtures with cohesionless fines, and it is also believed that the presence of cohesive fines can act as inhibitors to cementious reactions.

Varying percentages of cement (1, 2, 3, 4, 5, and 7%) were added to the samples to investigate the effect of cement content on the UCS.

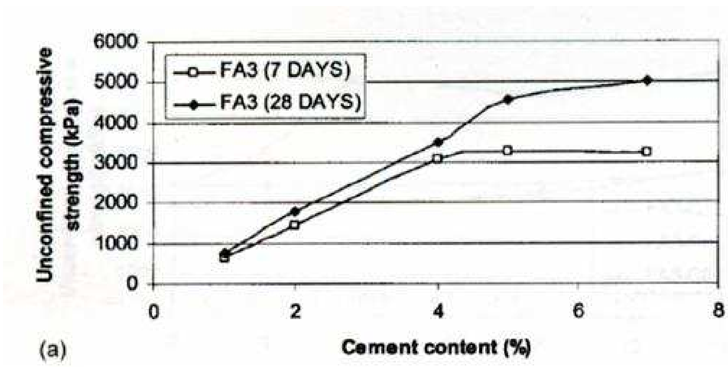

Figure 2.14 UCS values for varying cement content (Arora & Aydilek, 2005)

These samples were then tested after 7 day and 28 day curing periods. The results of the tests can be seen in figure 2.14 above. The UCS tests indicate that for the sample which is cured for 7 days, the strength initially increases with increased cement content. The results also show that there is no further increase in strength observed beyond the 5% cement content. The results for the 28 day period are similar with strength increasing with increased cement content up to 5% and the rate of strength increase decreased beyond this point

The effect of lime content on the UCS of the soil is illustrated in figure 2.15 below.

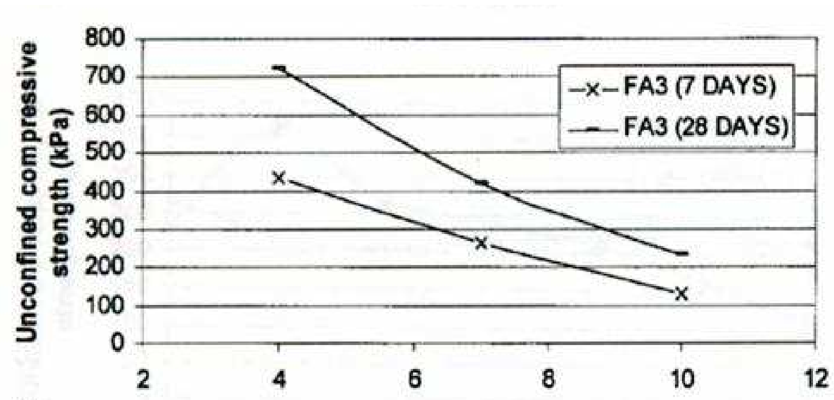

Figure 2.15 UCS values for varying lime content (Arora & Aydilek, 2005)

The trend for this data is clear, with both the 7 day and 28 day specimens showing a trend for decreased strength with increased lime content. It is believed that this trend has occurred as the fines which are present in the natural soil are non-plastic fines, and lime is generally used for the stabilisation of high plasticity clays. When lime is added to these clays, the trend is for a decrease in plasticity and an increase in the

UCS. Thus as the fines are non-plastic; this is believed to be the cause for the detrimental effect of the lime. Unconfined compression tests were also conducted on mixtures with cohesive fines (FA3K-L7), which were stabilised by lime, to compare the results with those obtained for the cohesionless mixtures. The results are shown in figure 2.16.

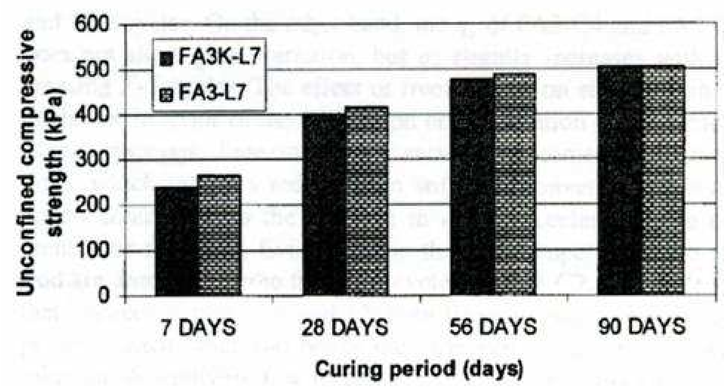

Figure 2.16 UCS values for varying lime content (Arora & Aydilek, 2005)

This indicates that the cohesionless mixtures (FA3-L7) give very similar results to mixtures that contained the cohesive fines (FA3K-L7). The presences of the cohesive fines were expected to generate a larger UCS than that of the cohesionless sample, but this is not the case because the amount of cohesive fines added was not sufficient to increase the soil's plasticity significantly. It is believed that a plasticity index of at least 10 is required for the soil to be suitable for lime stabilisation. There were to confirm the theory, however, no tests conducted on samples with a plasticity index greater than 10 to compare with the results obtained.

CBR tests were conducted to assess the effect of cement and lime content on the soil. The values obtained are shown in table 2.13.

These show that the CBR values of the samples increase with cement content and do not change significantly beyond the 5% content. The CBR tests show quite low values for the samples that were activated by lime compared to those activated with cement. This is consistent with the results from the UCS tests, which showed that lime stabilisation did not produce beneficial strength characteristics.

Table 2.13 CBR values for 7 day cured samples (Arora & Aydilek, 2005)

Mixture design	CBR
FA3-C1	53
FA3-C2	80
FA3-C4	93
FA3-C5	133
FA3-C7	140
FA3-L7	36
FA3K-L7	26

The CBR tests also demonstrate the similarity of the strength characteristics between the 2 samples that are activated by lime, even though it is believed that soils with cohesive fines will produce better strength characteristics for lime stabilised soils. The sample to which cohesive fines were added (FA3K-K7) obtained a CBR value of 26, while the cohesionless sample actually obtained a higher CBR value of 36.

The resilient modulus is considered as a very important strength parameter for pavement design (Little, 2000), as it describes the deformation of a material due to repeated loading similar to actual pavement loading conditions. The results of the resilient modulus are shown in figure 2.17 below, for samples with varying cement content and cohesionless fines. Because the variation in OMC for the samples is small (OMC ranges from 16.7-18.2%), and the difference between the dry densities of the specimens is insignificant, the variation in the resilient modulus of the samples can be attributed solely to the variation in cement content.

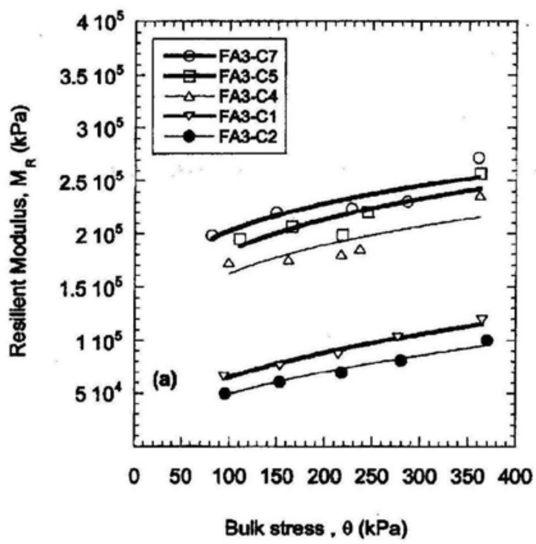

Figure 2.17 Resilient modulus values for varying cement content (Arora & Aydilek, 2005)

The trends shown in figure 2.17 are that increasing cement content results in an increase in the resilient modulus. It can also be observed that the rate of increase of resilient modulus decreases after 4% cement. This is similar to the results for UCS which showed that the rate at which the UCS increased with increased cement content decreased after 5% cement.

The results for resilient modulus tests for lime treated samples are shown in figure 2.18.

The results of the resilient modulus tests indicate that cement treatment is far more effective for cohesionless soils, as opposed to soils containing cohesive fines, as the resilient modulus for the cohesionless sample (FA3-C7) is much higher than that of the cohesive sample (FA3K-C7). Also the resilient modulus of the cement treated sample (FA3K-C7) is much higher than that of the lime treated sample (FA3K-L7), indicating that cement treatment is far superior to lime treatment, even with the presence of 10% cohesive fines, which should increase the effectiveness of the lime treatment.

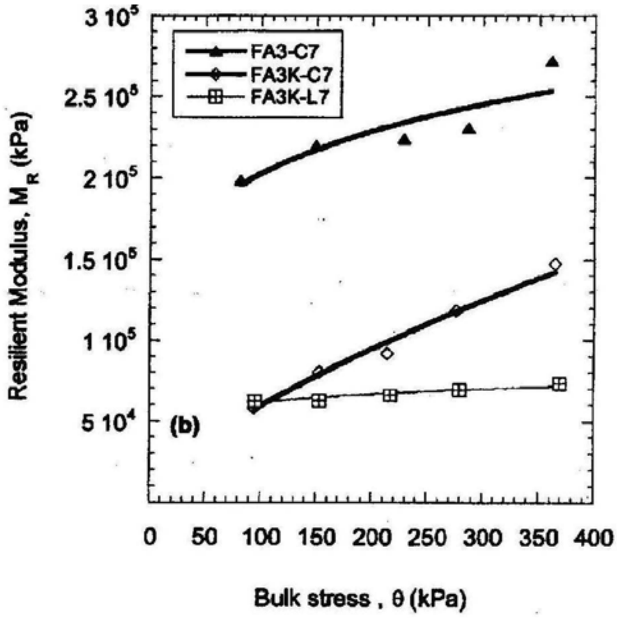

Figure 2.18 Resilient modulus values for varying lime content (Arora & Aydilek, 2005)

This investigation concluded the following:

1. The addition of 10% kaolinite generally increased the strength of the cement stabilised mixtures compacted at OMC.
2. CBR, q_u, M_R increased with increased cement content up to 5% cement
3. Lime treatment had a detrimental effect on sample strength for those containing cohesive fines performed worse in the UCS and CBR tests during lime treatment
4. Cement treatment provided samples with improved durability, as the q_u of the samples increased with increased numbers of freeze-thaw

cycles. The presence of kaolinite was observed to have a detrimental on the durability of the cement treated samples

5. Lime treated samples performed worse in durability tests than the cement treated counterparts as the strength of the samples decreased with an increased number of freeze-thaw cycles.

- *The stabilisation of Alcoa red sand for use as an embankment fill*

An investigation was conducted by Jamie Bennett (2004) into using lime kiln dust (LKD) and fly ash (FA) stabilised red sand (RS) as an embankment fill. The red sand used was the same unprocessed red sand as was used in this investigation, thus enabling direct comparisons to be made between test results.

The following laboratory tests were conducted on stabilised red sand to establish the engineering properties of the stabilised soil to determine if it was suitable for use as an embankment fill material.

- Direct shear test (Shear Box)
- California Bearing Ratio (standard compaction method)
- Consolidation (one dimensional consolidation – standard method)
- Constant head permeability
- UCS

The mix proportions used by Bennett were derived from previous research which had been conducted in the field of soil stabilisation. There were 8 mixes trials in all, with 4 of the mixes having different proportions of fly ash and lime kiln dust used for testing the various strength parameters, with the lime kiln dust content held constant at 5%, and the proportion of fly ash then varying between 15-30%. There was also control mixes of 100% red sand and 100% fly ash included as well as mixes with just red sand and lime kiln dust, and just fly ash and lime kiln dust so that the strengths of the cemented materials could be compared to these.

The shear box test gives an indication of a soil's ability to resist shear forces. The results for the shear box test are shown in figure 2.19.

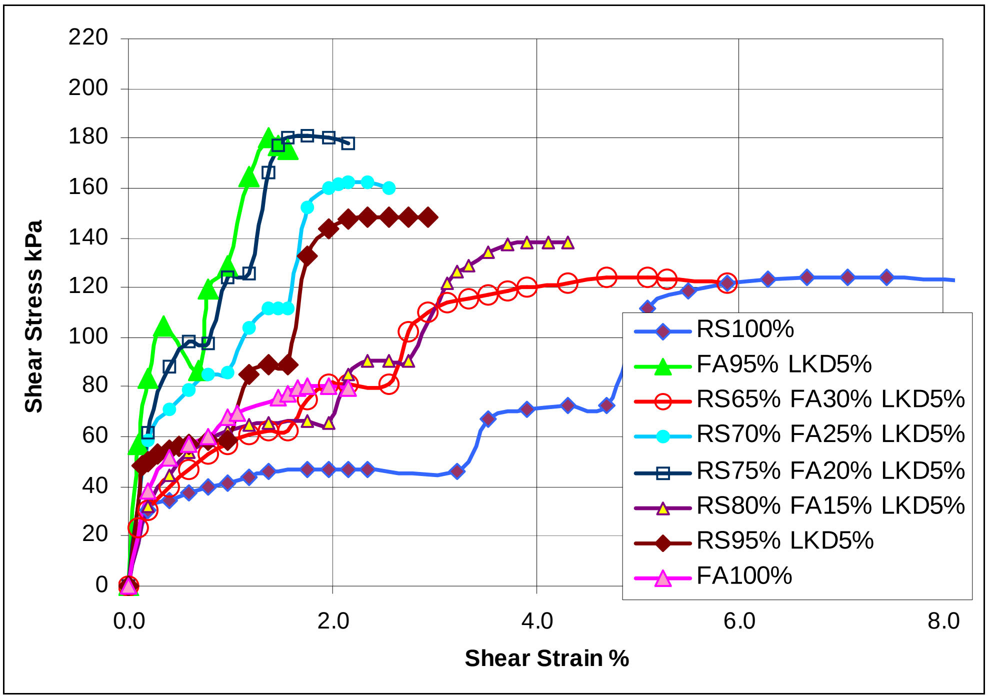

Figure 2.19 Shear strength values for varying lime and fly ash content(Bennett, 2004)

The results from the shear box tests show that there is an improvement in the shear strength of the soil with the addition of fly ash and lime. The results also indicate that the addition of fly ash and lime kiln dust increase the stiffness of the red sand considerably, with the mix of 100% fly ash failing at a strain in excess of 8%, whereas the stabilised mix which showed the highest shear strength, the RS75%, FA20%, LKD5% mix failed at a much lower strain of approximately 2%. This increased stiffness can be attributed to the cementious binding properties created by the pozzolanic activity generated by the chemical reaction between the fly ash and lime kiln dust. The results of the UCS tests are shown in figure 2.20.

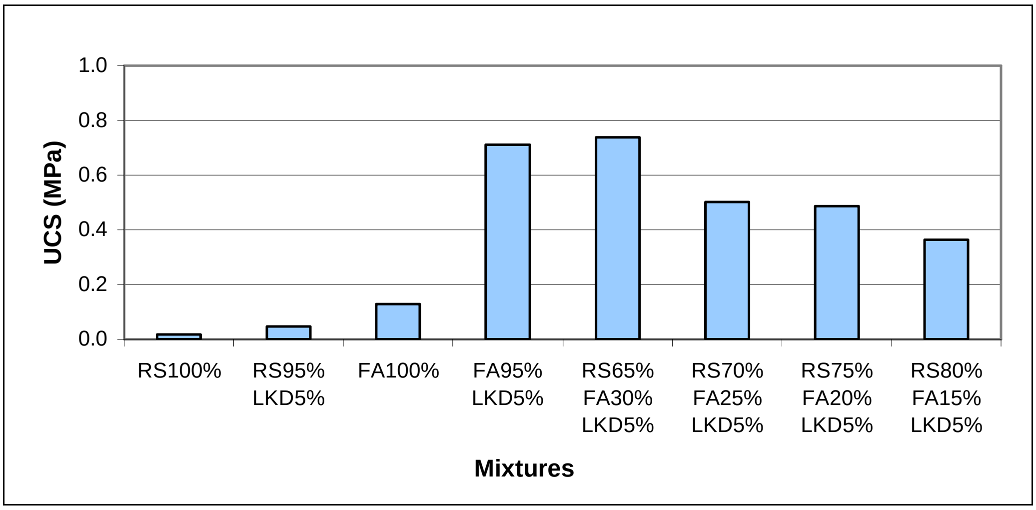

Figure 2.20 UCS values for varying lime and fly ash contents (Bennett, 2004)

The UCS of a soil indicates the soils ability to resist a compressive load with no lateral restraint and is frequently used to compare the compressive strengths of stabilised (cemented) mixes.

The test results show that the addition of lime and fly ash greatly improved the compressive strength of the soil. The UCS for the 100% red sand was <0.1MPa, and the UCS for RS65%, FA30%, LKD5% was a greatly improved 0.74MPa. This UCS result of 0.74MPa was the highest of the 4 stabilised mixes which had both fly ash and lime kiln dust added, however all 4 mixes showed marked improvements over the mix which contained 100% red sand.

Main Roads requires that for stabilised material to be used in flexible pavements, the 7 day UCS must be less than 1 MPa to ensure the material is not to rigid, meaning that all these mixes are plausible for use in flexible pavements.

The California Bearing Ratio (CBR) can be defined as a soil’s ability to resist applied loading without failing in shear. The CBR is a means by which the strength of soil can be compared and is thus important to pavement design.

The CBR values for the stabilised soil were compared with the 100% red sand mixture in table 2.14.

The CBR tests results show that there is a vast improvement in the soil’s bearing capacity with the addition of lime and fly ash, with the RS65%, FA30%, LKD5% mix achieving a CBR value 145% greater that of the red sand alone.

Table 2.14 CBR values for varying lime and fly ash contents (Bennett, 2004)

Mixture (%)	**CBR (%)**
RS100	25
FA95 LKD5	80
RS65 FA30 LKD5	170
RS70 FA25 LKD5	130
RS75 FA20 LKD5	70
RS80 FA15 LKD5	60

Permeability is a measure of the ability of water to pass through a medium. Constant head permeability tests are used predominantly on sands, which is why this method has been adopted to determine the permeability of the red sand. Soils with poor particle size distributions have high permeability's due to the lack of fines resulting in large voids being present in the soil, allowing water to pass through with greater ease.

The results of the constant head permeability tests are shown in figure 2.21. Because of the lack of fines in the natural red sand, there are a relatively large number of voids present due to the lack of fine particles in the mixture, which is reflected in the medium permeability of the red sand (1.1×10^{-4} m/s). The addition of 5% lime kiln dust can be seen to lower the soil's permeability considerably to 3.9×10^{-4} m/s, due to the fine particle size of the lime kiln dust which fills the voids present in the red sand.

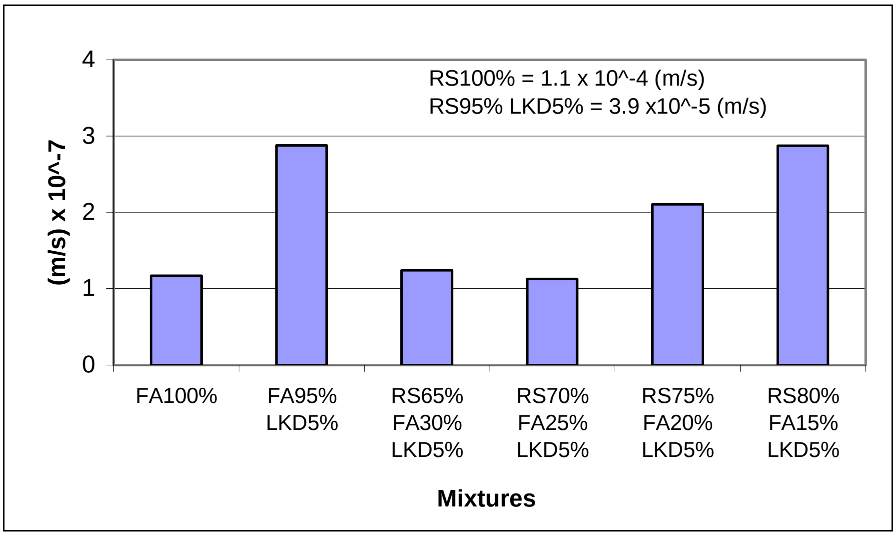

Figure 2.21 Permeability for varying lime and fly ash contents (Bennett, 2004)

The test results revealed that the soil shear strength and compressive strength are increased considerably through the addition of fly ash and lime. The strength parameters which were tested in this investigation found that the optimum proportions of fly ash and lime for the stabilisation of unprocessed red sand was RS65%, FA30%, LKD5%. The addition of fly ash and lime also decrease the soils permeability, meaning leaking water, a considerable issue in embankment design, can be somewhat resolved through the addition of fly ash and lime. The soil properties of the optimum mixture of red sand, fly ash and lime kiln dust were thus found to be adequate in resisting the deformation forces placed on embankments. Furthermore, if a higher strength sub-grade is used in embankment construction, the height of pavement layers and slope of embankment batters can be reduced, thus reducing costs.

- *The stabilisation of Alcoa red sand using fly ash and lime kiln dust for use in rigid pavement design*

Hirsiger (2005) conducted tests using high silica red sand, stabilised with lime and fly ash, for a fill material in rigid pavements. The laboratory tests which were used to determine the strength parameters of the soil were direct shear test, CBR, and UCS. The results were then compared with the standard requirements provided by Main Roads to determine if the stabilised soil was a suitable replacement for conventional fill.

The shear box test is used to determine how well soil resists shearing forces and is predominantly utilised for testing cohesionless soils. The fly ash and lime kiln dust being used in this investigation was classified as a silt, which suggests that the test will not give an accurate value for the soils shear strength but it was, however, conducted so that a comparison could be made between the samples.

The shear box test results are shown in figure 2.22. The highest shear strength 124 kPa was apparent in mix 2. This sample was, however, considerably more brittle than the mix with 100% red sand as the ultimate shear strength occurred at a 3.2% shear strain, compared with 17% for the sample with 100% red sand.

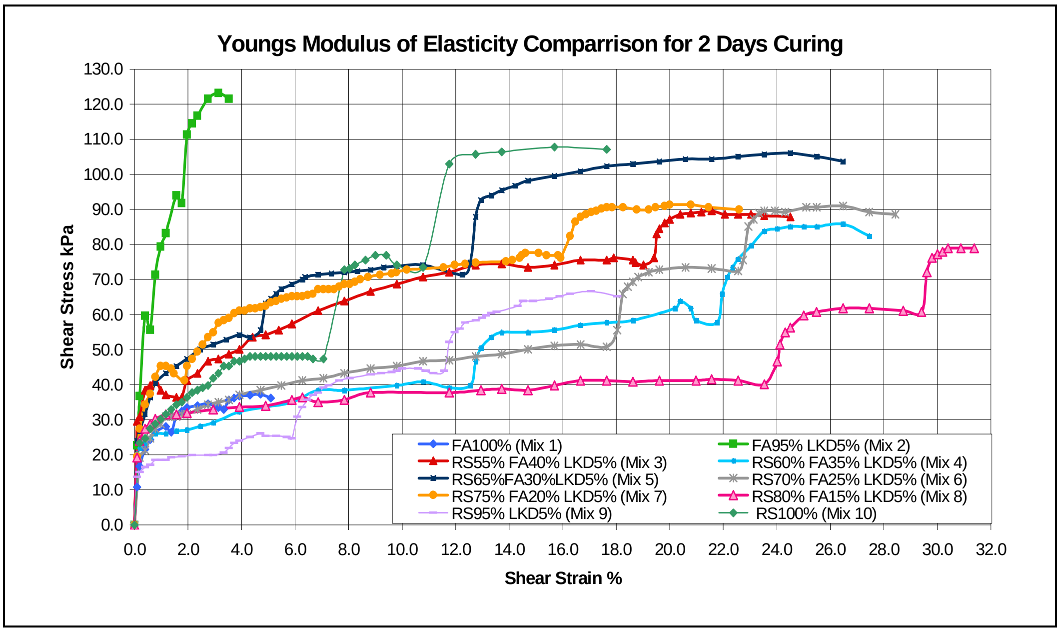

Figure 2.22 Shear strength values for varying lime and fly ash contents (Hirsigner, 2005)

The general trend was, however, for the samples which were stabilised with fly ash and lime to have lower shear strengths and greater Young's Modulus of Elasticity. In terms of comparing the results obtained by Hirsiger (2005) using high silica red sand with the results obtained by Bennett (2004), using unprocessed red sand, the only correlation is that the samples of unprocessed red sand generally performed better than the samples of high silica red sand with 2 day curing.

It was suggested by Hirsiger (2005) that the red sands main contributor to shear strength was the internal friction (ϕ) and the smaller spherical particles of the added fly ash provided the cohesion. All mixes containing high silica red sand displayed a constant decrease in ϕ values, when compared to the unprocessed red sand, suggesting that the standard red sand showed more favorable shear strength characteristics. The addition of LKD in all mixes generated an increase in internal friction and cohesion as the addition of the lime created the cementious stabilised material.

For the CBR tests, samples were prepared with OMC and left to cure overnight to achieve consistent moisture content before compaction. After 24 hours the specimens were compacted by standard apparatus. The samples were left to cure for 4, 7 and 14 days before being subjected to CBR tests.

The test results of the CBR summarised in table 2.15 and indicate that there is a dramatic improvement in the CBR value of the red sand after the addition of the lime and fly ash. Mix 10 which contained 100% red sand obtained a CBR value of 0.38 after 4 days of curing, whereas Mix 5 which was stabilised by fly ash and lime obtained a CBR value of 66 after 4 days of curing, a dramatic improvement. The CBR value of Mix 5 also increased to 139 after 14 days of curing, which is 366 times greater than the 4 day CBR value of the standard red sand.

Table 2.15 Change in CBR over time (Hirsigner, 2005)

Mix	Mixture	CBR (%)		
		4 days	7 days	14 days
Mix 1	FA100%	8	NA	NA
Mix 2	FA95% LKD5%	17	NA	NA
Mix 3	RS55% FA40% LKD5%	17	24	58
Mix 4	RS60% FA35% LKD5%	18	28	71
Mix 5	RS65% FA30% LKD5%	66	93	139
Mix 6	RS70% FA25% LKD5%	48	76	111
Mix 7	RS75% FA20% LKD5%	22	48	83
Mix 8	RS80% FA15% LKD5%	6	14	26
Mix 9	RS95% LKD5%	3	NA	NA
Mix 10	RS100%	0.38	NA	NA

The UCS value of the soil is an effective means of comparing the strength of different samples. The scope of this investigation allowed for 4 different curing periods, 4, 7, 14 and 28 days. There were also both wet and dry samples to determine the potential impact of soil saturation on the sample's strength. For the wet samples, the specimens were placed into position in the triaxle testing machine and saturated by placing water into plastic bags around them, suspending the handles to avoid collapse of the plastic bags.

The results of the UCS tests are summarised in table 2.16. The results highlighted in red are the samples which failed prematurely due to saturation.

Table 2.16 UCS results (Hirsigner, 2005)

Mix	Mixture	Curing Period							
		4		7		14		28	
		Dry	Wet	Dry	Wet	Dry	Wet	Dry	Wet
Mix 1	FA100%	0.04	0.00	NA	NA	NA	NA	NA	NA
Mix 2	FA95% LKD5%	0.25	0.00	NA	NA	NA	NA	NA	NA
Mix 3	RS55% FA40% LKD 5%	0.37	0.00	0.52	0.00	0.68	0.42	0.92	0.58
Mix 4	RS60% FA35% LKD 5%	0.49	0.24	0.60	0.37	0.79	0.49	1.17	0.72
Mix 5	RS65% FA30% LKD5%	0.17	0.08	0.22	0.13	0.43	0.27	0.62	0.40
Mix 6	RS70% FA25% LKD5%	0.26	0.13	0.27	0.17	0.51	0.32	0.66	0.43
Mix 7	RS75% FA20% LKD5%	0.15	0.07	0.20	0.12	0.31	0.19	0.50	0.31
Mix 8	RS80% FA15% LKD5%	0.07	0.00	0.14	0.00	0.19	0.00	0.31	0.19
Mix 9	RS95% LKD5%	0.03	0.00	NA	NA	NA	NA	NA	NA
Mix 10	RS100%	0.08	0.00	NA	NA	NA	NA	NA	NA

The results of the UCS tests indicate that there is an increase in the compressive strength of the samples with the addition of fly ash and lime. Mix 10 which contained 100% red sand had a dry UCS of 0.08 MPa, whereas the mixes which were stabilised with fly ash and lime showed UCS values as high as 0.49 MPa for the 4 day curing period. The 28 day UCS dry strength of Mix 4 also gave a vastly improved value of 1.17, indicating that the compression strength of dry red sand benefits greatly from fly ash and lime stabilisation.

For the wet samples, the mix with 100% fly ash failed prematurely upon saturation, indicating a high level of instability in standard red sand. The general trend for the saturated samples was that the compressive strength of the sample was greatly reduced upon saturation and in most cases the UCS of the wet samples was roughly 50% of the dry UCS.

Comparisons were made between the results obtained from Hirsiger (2005) testing of high silica red sand (HS Red Sand) and the results obtained by Bennett (2004), for the UCS values for unprocessed red sand (Std Red Sand). The comparisons are shown in figure 2.23.

The results indicate that the wet UCS values of the standard red sand consistently exceed that of the high silica red sand by considerable margins, suggesting that the standard red sand performs better under saturated conditions than the high silica red sand.

The strength based test results indicates that all red sand samples that underwent fly ash and lime stabilisation outperformed the remaining mixes. In comparison to concrete strength however, the stabilised mixes performed poorly, but this was to be expected.

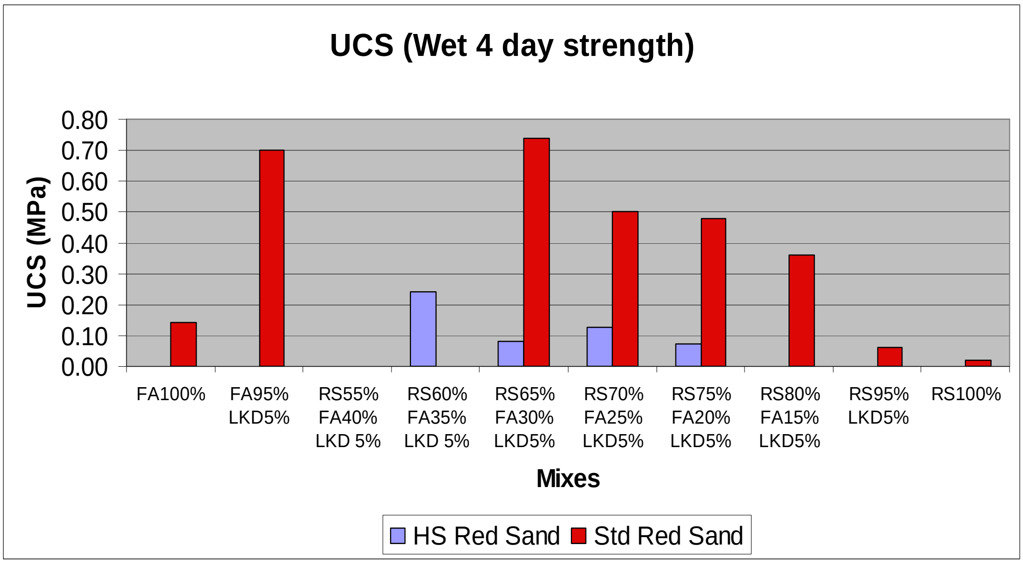

Figure 2.23 Comparative analysis of UCS for 4 day wet samples (Hirsigner, 2005)

Main Roads in Western Australia requires CBR values of 20% and 60% for crushed limestone. Mix 5 and Mix 7 recorded CBR values greater than 20% and Mix 6 recorded a CBR value greater than 60% at 4 days of curing time. Thus the CBR results indicated that the stabilised high silica red sand does produce a plausible pavement material.

One interesting result obtained from the various curing periods that were used for the strength based tests was that unlike concrete, which has gained the vast majority of its strength by the 28 day period, the samples tested indicated that there could be significant gains in strength to be seen if the curing period is extended past the 28 day period.

Although previous testing of standard red sand indicates that the stabilised material can perform in a rigid manner, in this investigation, the samples derived from high silica red sand did not behave in a rigid manner suggesting that the standard red sand would be better suited to the application of rigid pavement design.

From the findings, it may be concluded that the performance of the stabilised high silica red sand does not have sufficient strength characteristics to have an application in rigid pavement.

2.3 Pavements

The purpose of a pavement is to sustain the designed traffic load as well as providing a smooth driving surface. There are two pavement categories, flexible and rigid pavements. Flexible pavement is different to rigid pavement in terms of the surface, asphatic materials for a flexible road system and reinforced concrete for a rigid road system. The soil layer beneath the surface is usually named the base layer. The ideal feature of this material is that it should not be costly and provide good enough strength and stiffness for distributing the applied load in an acceptable magnitude to the subgrade layer (usually the in-situ soils) so the intense traffic load cannot damage the subgrade for all the road design life.

2.3.1 Flexible pavements

For flexible pavements, there are typically two bases underneath the asphatic surface system that comprise the road base, a stabilised base and an untreated or granular subbase. Two different base materials are usually used for economy, local or cheaper materials in the subbase and selected materials (more expensive) in the base layer. These layers deform under traffic load and distribute the stress onto the subgrade. A flexible pavement is primarily composed of a series of granular layers topped by a relatively thin, high-quality surface wearing bituminous layer. Figure 2.24 shows the flexible pavement system.

With most flexible pavements, the quality and thickness of each layer is different from the other layers within the pavement. Generally it can be noted that the thickness is inversely proportional to the quality. Therefore it can be said that as the layers near the surface, the quality of the soil increases to better withstand the traffic loads.

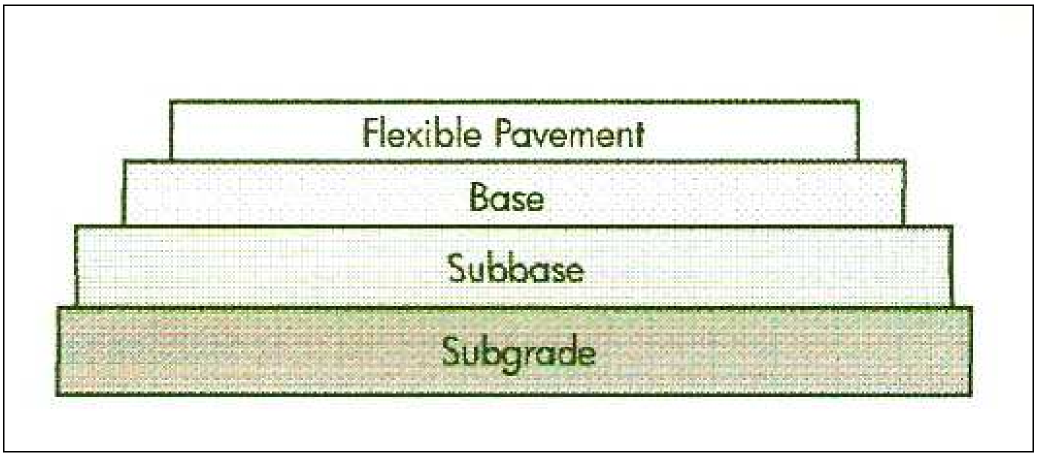

Figure 2.24 Schematic of a flexible pavement structure (Federal Highway Administration, 2004)

The subgrade is commonly the foundation of the existing natural earth but it may also be composed of selected compacted fill positioned during earthworks operations (Nikraz, 2004). If the subgrade contains unsuitable characteristics, it may be stabilised. Conversely when this does occur, the section of stabilised sub-grade is generally considered a lower sub-base section, hence part of the pavement and not part of the subgrade (Nikraz, 2004).

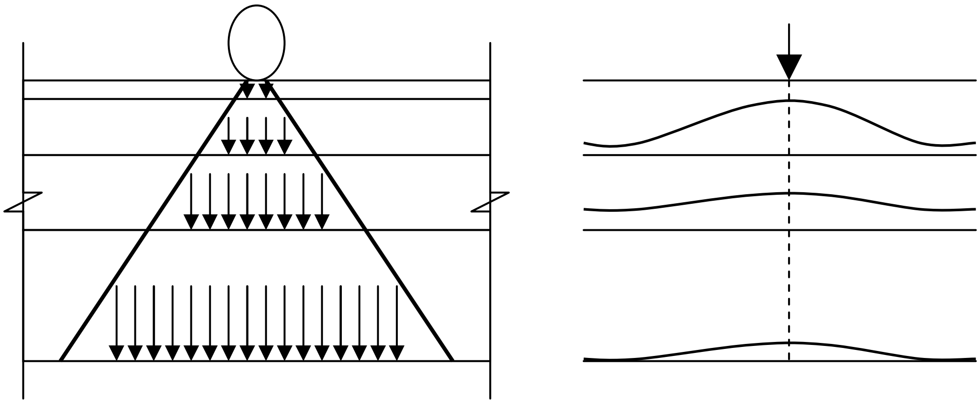

Figure 2.25 Stress distribution of flexible pavement layers (Hirsigner, 2005)

The sub-base course is the layer situated between the subgrade and base course. Its function includes providing additional thickness to the whole pavement, forming a barrier between the subgrade and base course which can experience intrusion between the two layers, and providing a working surface for machinery over a fragile subgrade (Nikraz, 2004). As the course lies adjacent to the subgrade, it usually contains material of inferior quality compared to the base course which may be composed of one or multiple layers containing one or more types of material, or depending on requirements the subbase may be omitted.

The base course is located near the surface and provides most of the load carrying capabilities of the pavement. Its principle purpose is to provide sufficient cover to limit the stresses and strains of wheel loading so that shear failure and deformation do not occur. It can be composed of one or more types of materials, natural gravel, fine crushed rock, broken stone and stabilised soil (Nikraz, 2004).

The surface course is purposely designed to withstand cyclic traffic loads as well as providing a protective seal against excess water penetrating the lower courses from above (Wright, 1996). It usually consists of multiple bituminous layers either spray sealed or of an asphalt consistency. The wearing surface can range in thickness from 25 mm of bitumen for low traffic areas to 150 mm or more or asphalt concrete for heavy traffic areas. However, if the pavement is for low traffic volume use, it may be unsealed with the top surface coat forming part of the base course.

2.3.2 Rigid pavements

In contrast to flexible pavements, rigid pavements are typically placed on a single layer of granular or stabilised road base material (see figure 2.26). Since there is only one layer under the rigid pavement and above subgrade, it can be called either a base or a subbase. The selection of a stabilised base course or a granular base course depends on the traffic load. Pavements that are subjected to a large number of very heavy wheel loads typically use cement-treated, alphalt-treated, or a pozzolanic stabilised mixture (PSM) base. Granular materials may erode when the heavy traffic induces pumping (Federal Highway Administration, 2004).

2.3.3 Pavement materials

The primary objective of the base course layer is to distribute and reduce the applied stresses created by traffic loads. This enables transmitted stresses to be sufficiently low as to not result in excessive deformation or settlement for the foundation layer. Another requirement of the base course is that it should also be able to withstand the destructive affects of water and frost. Materials for the base course are normally locally sourced. If local materials are not suitably strong, they can be stabilised through granular material or treated with cement or fly ash-lime stabilisation. Multiple layers may be utilised for economic purposes whereby a cheaper, weaker material is used for the majority of the base course, with an overlaying strong layer.

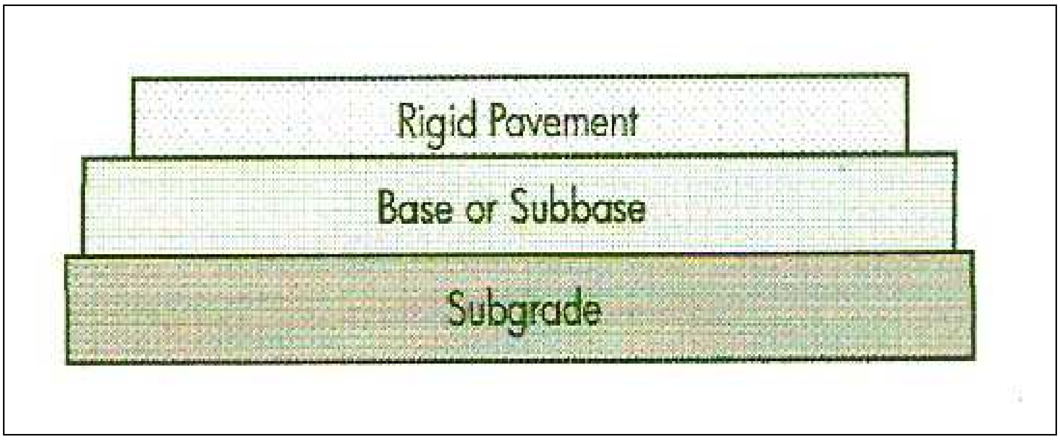

Figure 2.26 Schematic of a rigid pavement structure (Federal Highway Administration, 2004)

2.3.4 Flexible pavement design

Flexible pavement design is a process whereby the optimum arrangement of materials is chosen, with suitable strength, serviceability and economic achieved for the given applications. It can be achieved by either the empirical or mechanistic method. The empirical method is suitable for pavements composed of granular material or a pavement containing an asphaltic surface layer of less than 30 mm in thickness. Pavements containing bound or cemented material or asphalt thicknesses of 30 mm or greater, require the mechanistic design method to be used instead (Nikraz, 1998). This is because the empirical method uses an estimated approach to serviceability and fatigue analysis that limits its use to low trafficked applications, whereas the mechanistic takes a closer look at the mechanics of the pavement.

Empirical pavement design procedures rely to some extent on the engineer's knowledge and experience of flexible pavements. The design procedure is based on four main components (Nikraz 1998):

- Prediction of design traffic
- Assessment of material's bearing capacity (based on California Bearing Ratio), elastic parameters, modulus of subgrade reaction (*k*)
- Determination of pavement thickness from Figure 2.27
- Determination of pavement composition

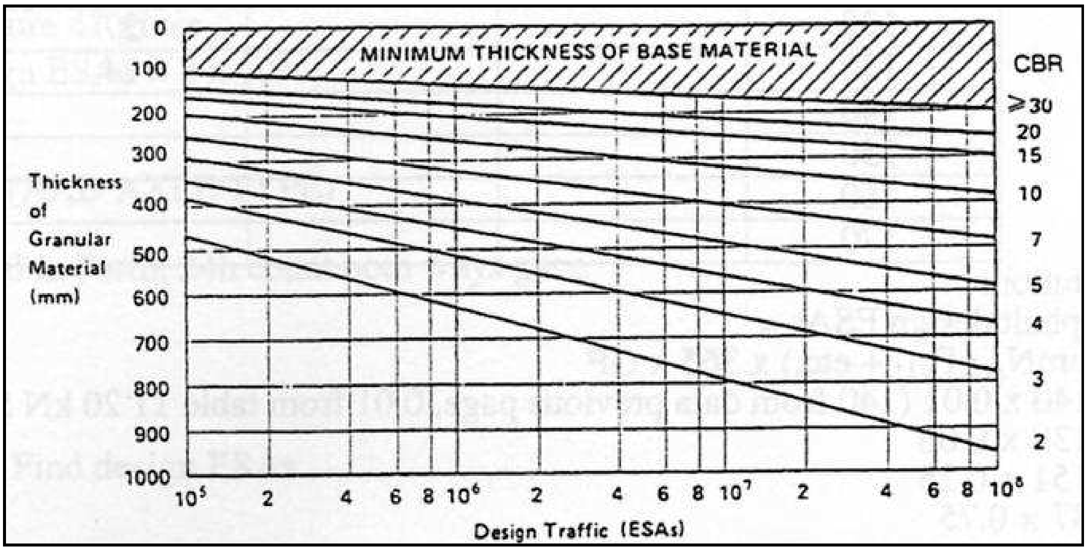

Figure 2.27 Design chart for granular pavements (Austroads, 2004)

The use of empirical design as a reliable pavement design method is limited for it does not consider variances in fatigue, material behaviour and climate. Instead it provides a general solution to these aspects. To increase the reliability of the design, an analytical approach known as mechanistic design was developed.

The mechanistic design approach relies on two main parameters, resilient modulus and permanent strain. This is where the non-linear elasticity and plasticity of the pavement materials are established in relation to vehicle – pavement interaction. The design is centred on the structural analysis of pavements with multiple layers and steps for mechanistic pavement design are as follows (Nikraz, 1998);

1. Evaluate the multiple input considerations namely, construction and maintenance parameters, environmental aspects, subgrade, materials, traffic and performance criteria.

2. Choose a test pavement.

3. Analyse the test pavement to determine acceptable traffic.

4. Evaluate the acceptable traffic with the design traffic. From a comparison, the pavement is either accepted or rejected. If the test pavement is rejected, a new test pavement is chosen, and the procedure is repeated until a suitable pavement is achieved.

The two main modes of failure met with in the mechanistic approach are failure by excessive deformation or fatigue. For flexible pavements, fatigue occurs mainly at the bottom of the surface, asphalt layer and is caused by the tensile strain in the horizontal axis induced by traffic loading (see Figure 2.28).

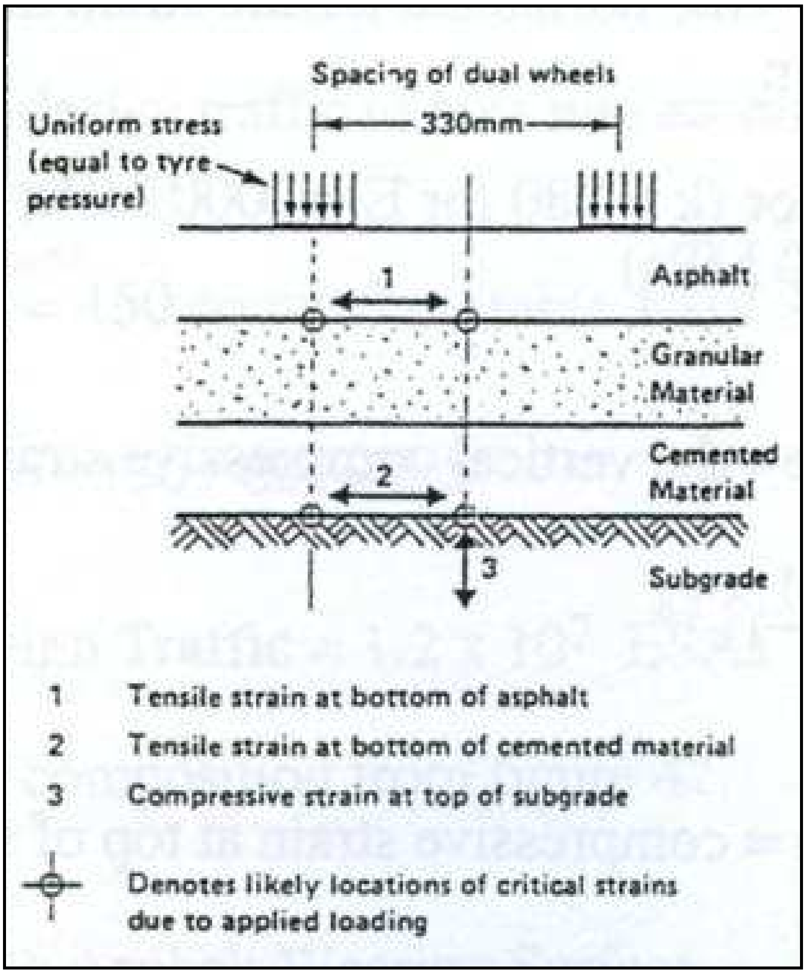

Figure 2.28 Strains induced in a layer pavement system (Austroads, 2004)

The resilient modulus (M_r) the equivalent modulus of elasticity of the materials in the pavement is established on the recoverable quantity of strain, after axial stress is removed. It is defined as the ratio of deviator axial stress (σ_d) to the resilient axial strain (ε_r).

$$M_R = \frac{\sigma_d}{\varepsilon_r} \tag{2.9}$$

Where:

M_r = Resilient modulus

σ_d = Axial stress

ε_r = Resilient axial strain

The resilient modulus can be found through Repeated Load Triaxial Test (RLTT) conducted in laboratories. This method of analysing pavements is becoming popular in Australia, because of its ability to better analyse the pavement. However, there still exist problems with sample end effects, system deflection and noise, sample bending and friction and compaction method effects. Technology in this field is advancing, allowing for evolution of data analysis and standardisation of test procedure to increase accuracy.

With pavement aspects such as resilient modulus, Poisson’s ratio and shear modulus known, mechanistic analysis and pavement design can be performed using of computer programs such as CIRCLY. CIRCLY (MINCAD Systems, 2004) is a commonly used pavement analysis program in Australia and forms an important part of the Austroads Design Guide (Austroads, 2004).

The mechanistic design is known in figure 2.29. The procedure consists of:

- evaluating the input parameters (structure, material, traffic, and climate),
- selecting a trial pavement,
- analysing the trial pavement to determine its responses in terms of stresses, strained, and deflection induced,
- determining the performance prediction, and
- comparing the performance with failure criteria.

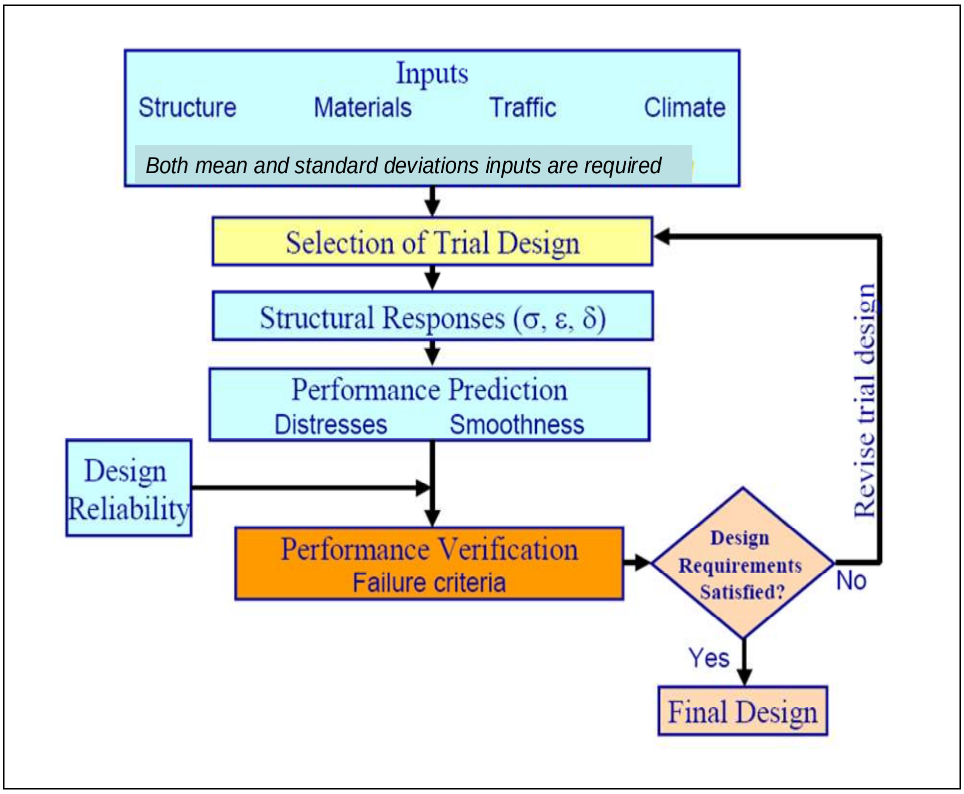

Figure 2.29 Mechanistic design frame work and component (Cement Association of Canada, 2005)

2.3.4 CIRCLY (MINCAD Systems, 2004)

CIRCLY is software for the mechanistic analysis and design of road pavements. CIRCLY uses state-of the-art material properties and performance models and is continuously being developed and extended. The first mainframe version of CIRCLY was released in 1977 and the current Windows version is CIRCLY 5.0. It is an integral component of the Austroads Pavement Design Guide (Austroads, 2004) widely used in Australia and New Zealand. The system calculates the cumulative damage induced by a traffic spectrum consisting of any combination of user-specified vehicle types and load configurations. As well as using the usual equivalent single wheel and axle load approximations, optionally the contribution, such as foundation engineering and settlement analysis, can also be analysed using CIRCLY.

CIRCLY is based on integral transform techniques and offers significant advantages over linear elastic analysis techniques, such as the finite element method.

2.4 Embankments

Embankments are essentially artificially created, trapezoidal structures that can serve a number of purposes, be it to provide adequate grades for traffic and trains or to control water or sound flow. In highway construction, most of the materials used as structural fills for embankments are primarily rock and soil. There are two main ways in which embankments are constructed; hydraulic–fill and the more popular rolled earth embankments.

Embankments have been known to vary greatly in size. The majority of used for road construction are 4.5m or less in height, however, they have been built up to 117 m high (Wright, 1996) which results in a very large structure when the required width is also considered. Therefore, embankment construction entails large construction works with the acquisition, spreading, levelling and compaction of great masses of structural fills. Like all major works, the contractor will try and source reasonably cheap, local structural fills for an economic reason. However if the contractor could obtain a cheaper alternate soil with equal or better strength characteristics located within a reasonable distance, vast amounts of money could be saved.

2.4.1 Embankment geometry

The embankment height is usually predetermined because of factors that affect the general location of the road. This includes factors such as gaining height to traverse bridge abutments, or to obtain the minimum vertical grade required. However horizontal curves may also need to be considered. For the construction of a major arterial road in a hilly area, it may not be practical for the road to follow the natural curve of the area for two main reasons. Firstly for traffic travelling at fast speeds, a greater line of sight is required, and the natural horizontal curves may not provide this. Also having a winding arterial road is less desirable to traffic users and may lead to some loss vehicle traction, as well as general wear and tear. It might, therefore, be desirable for an embankment to travel over dips in the hill to create a more desirable result.

Embankments are not only necessary to solve horizontal and vertical slope issues. In low lying areas that are within water zones, embankments might also be utilised. Their use can be vital in providing a dry surface for traffic to use in areas subjected to mass flooding. With roads that are inundated, vehicles can loose contact with the road surface producing an effect known as aquaplaning. This is where the tyres no longer have traction with the road and the driver has little or no control over the vehicle creating a dangerous situation. Also by providing additional height to the road, there exists sufficient elevation for the subgrade to avoid intrusion of moisture, creating a more durable pavement. A minimum height of 0.6m below the top of the subgrade was recommended in an American text (Wright, 1996). This increased height is recommended for soils that are subjected to capillarity.

2.4.2 Embankment slopes

Embankments slopes are critical with design of embankments. The side slopes determine the required base width, which basically determines the required amount of fill. Therefore the steeper the slopes, the less fill is required resulting in more economical saving. However, the angle of the slopes is dependant on the soil strength parameters used as the structural fill. Very high and steep slopes may be constructed if high quality materials could be utilised. This indicates that the maximum slope for an embankment would need to be determined separately for each case.

Looking at embankment design in a purely economic fashion, having the steepest slope possible would reduce the amount of structural fill and hence overall cost. An embankment with steeper slopes would, however, require suitable material with greater shear strength and slope. A steeper sloped and hence a thinner based embankment would also produce greater shear stress on the foundations of the embankment. This could lead to special treatment being performed on weak foundations or relocation onto stronger foundations. As increasing the side slopes of embankments can create its own engineering and economical problems, a medium should be reached between reduced fill through increased side slopes and material quality costs for both structural fill and foundations.

2.4.3 Embankment materials

Many soils are suitable as structural fill for the construction of embankments including mainly gravel and sandy soils, clayey soils being less suitable due to the special design and construction considerations that are required (Wright, 1996).

Coarsely graded sand is considered very suitable for embankment construction due to its high degree of stability and density once compacted sufficiently (Wright, 1996). Medium and fine graded sands are also possible; however they require special considerations for the control of compaction. Some silts and fine sands may also be appropriate for embankments under special conditions. These involve low embankments, careful control of compaction and in locations where the soil moisture is expected to remain the same or less than that used in construction of the embankment(Wright, 1996). The reason for this is because these types of soil tend to retain a significant amount of moisture. This makes compaction more difficult as well as being able to dispel any excess of moisture. Clayey soils are considered undesirable mainly because of their high sensitivity, which means they tend to produce massive volume changes with levels of moisture. This ability is unsuitable for embankments as the constant swelling and shrinking will produce undue stress on the embankment and result in premature failure.

2.5 Seawalls

Seawalls are used to protect a backshore area against wave actions. They may retain a low fill but they are intended primarily to withstand and to deflect or dissipate wave energy. In low wave areas, sheet-pile structures are usually used as seawalls; in moderate to very strong waves, rubble-mound toe protection should be provided. Figures 2.30 to 2.32 show some types of seawall structures.

2.5.1 Structural aspects

The U.S. Army Corps of Engineering (U.S. Army Corps of Engineers, 1981) has introduced important structural design aspects of seawalls that most sheet-pile seawalls are structurally similar to earth-retaining structures, although the simple cantilever type is not recommended. From the back fill protection point of view, soil behind the seawall may be scoured by overtopping waves and by flows of ground water through joints, cracks, and holes in the structure. Loss of soil to overtopping waves can be prevented by paving the ground surface behind the wall. Scoring by ground water flow can be controlled by placing a geotechnical filter fabric or a granular soil filter behind weepholes.

The depth and width of the base of a seawall and the dimensions of the shoreward sides should be chosen to insure stability under local foundation and scour conditions, but the height and the shape of the seawall face should be chosen to provide the desired type protection.

2.5.2 Design considerations

- If the seawall fronts a beach which cannot be sacrificed, a beach fill and additional protective structures may be needed.
- A seawall foundation has to be adequate to prevent settlement and resulting loss of the seawall height and structure integrity.
- A seawall must be stable against wave forces. Resistance to wave forces can be developed by providing gravity structures with adequate weight and base width.
- Overtopping, increased by wave reflection, may erode the area behind the seawall negating the structure purposes. Additionally, it may increase the weight of the backfill by accelerating saturation, leading to structure stability problems such as sliding and uplifting.
- A seawall should be designed to reduce and withstand scour at its toe.
- The removal of soil at the seawall toe by ground water flowing under the structure and the loss of backfill flowing through it, must be eliminated.

- The seawall must be safe against failure due to flanking. This can be prevented by tying the seawall ends to adjacent structures or turning them back into the existing upload.

2.5.3 Material selection

1. Quarry stone of suitable size and structural properties for use in sea wall construction is not always available so alternative materials as they have to provide a serviceability closeto quarry stones.
2. The construction of a rubble-mound or massive concrete seawall involves the use of a variety of heavy construction equipment and requires access to the construction site for the equipment. Sheet-pile seawalls and cutoff walls are built using pile drivers which also require sufficient access and work areas.

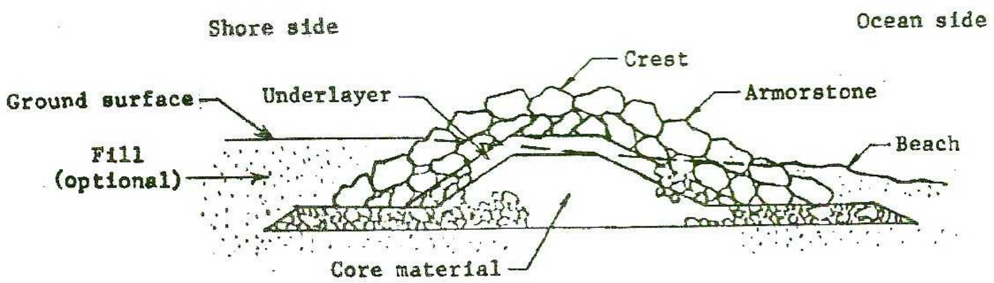

Figure 2.30 Rubble-mound seawall (U.S. Army Corps of Engineers, 1981)

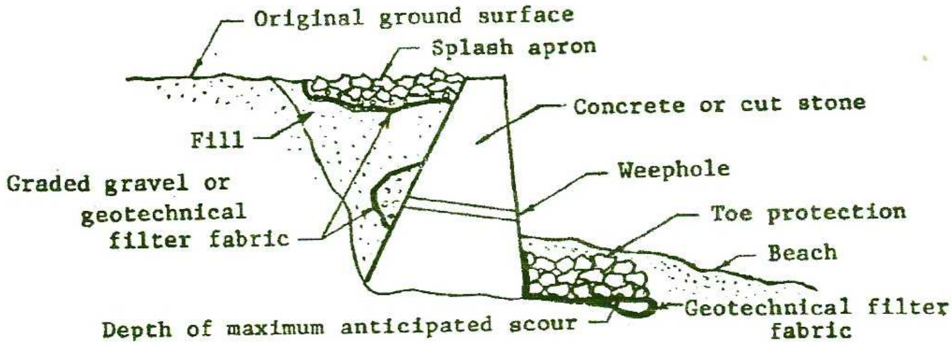

Figure 2.31 Concrete or masonry seawall (U.S. Army Corps of Engineers, 1981)

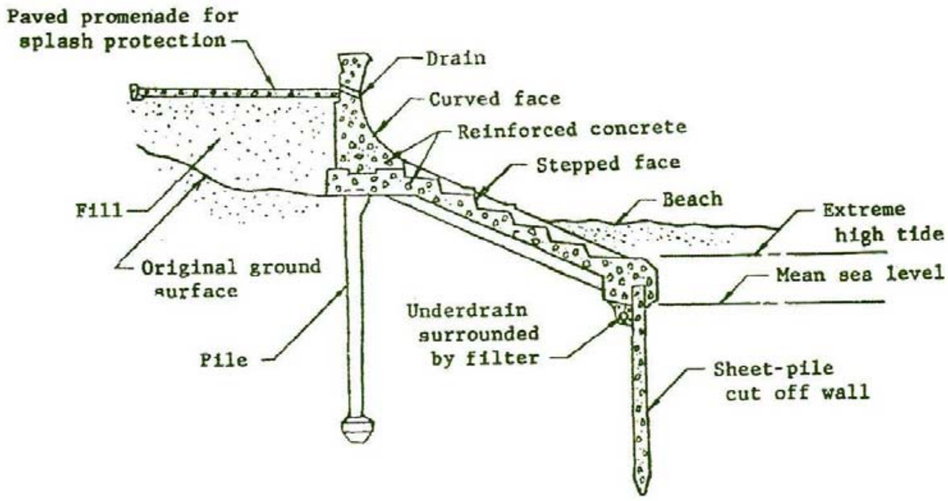

Figure 2.32 Reinforced concrete seawall with combination stepped and curved seaward face (U.S. Army Corps of Engineers, 1981)

CHAPTER 3

RESEARCH METHODOLOGY AND EXPERIMENTAL PROGRAM

3.1 Overview

This chapter introduces the research methodology and the experimental program followed in the present study. The main objective is to evaluate the possibility of using red sand as a material for road bases, embankments, and seawall fills constructions. The research plan was designed to facilitate laboratory work and can be seen in figure 3.1.

To achieve this objective, the research methodology and the experiment program were divided into four parts;

- The methodology and the experiment program of red sand characterisation,
- The methodology and the experiment program of red sand for road bases,
- The methodology and the experiment program of red sand for embankments, and
- The methodology and the experiment program of red sand for seawall fills.

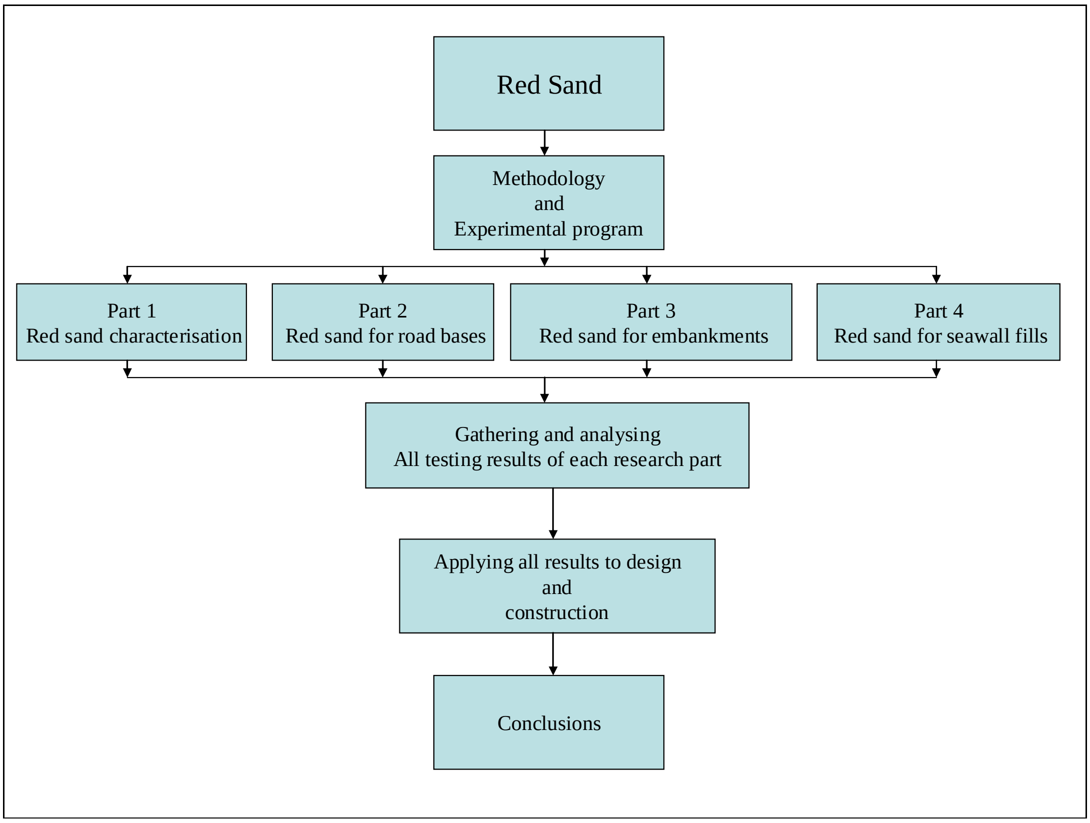

Figure 3.1 Overall research plan of the study

When the methodology and the experiment programs of each part were completed, gathering and analysing all test results of four research parts was then carried out after which the application of the results in this study to design and construction of road bases, embankments, and seawall fills was addressed. Finally, conclusions were made.

In this chapter, a detailed description of the testing material is shown. Types, sources, sampling, and transportation, to the Geomechanics laboratory at Curtin University of Technology of red sand, are discussed. The methodology and the experiment program including testing methods and testing procedures of given tests in each research part then are presented.

3.2 Testing materials

Two types of Alcoa red sand were used, unprocessed red sand and washed and carbonated red sand. Both were sourced from Alcoa’s Kwinana refinery. Unprocessed red sand samples were collected randomly from an impoundment area and kept in sealed plastic containers with a cylindrical diameter of 350 mm and 350 mm in height as shown in figure 3.2. Samples were atmospherically carbonated prior to testing at the Department of Civil Engineering, Curtin University of Technology. One year later, a set of wash and carbonated red sand samples was transported to the laboratory; they were sealed in barrels - 600 mm in diameter and 850 mm in height as shown in figure 3.3. As Alcoa wanted to produce washed and carbonated red sand for use in real construction works, a pilot plant to produce washed and carbonated red sand was built and samples of such red sand for this research were obtained.

(a)

(b)

Figure 3.2 (a) and (b) Unprocessed red sand and its containers

(a)

(b)

Figure 3.3 (a) and (b) Washed and carbonated red sand and its barrels

3.3 Part 1: Red sand characterisation

In red sand characterisation, unprocessed red sand and washed and carbonated red sand were investigated of only the geotechnical characteristics. According to construction requirements the characteristics of construction materials which usually play a major role in structure qualities and performance are needed, the geotechnical properties of red sand, therefore, have to be determined to evaluate the possibility of its uses. Figure 3.4 shows the methodology of red sand characterisation.

A series of laboratory tests was came out to discover the important geotechnical properties of both red sand types.

The geotechnical characteristics which were investigated consisted of:

- Particle size distribution
- Particle shape
- Compaction
- Specific gravity
- Permeability
- California bearing ratio (CBR), and
- Strength.

Laboratory procedures carried out to detect these characteristics were mostly performed in accordance with Australian Standard Methods of testing soils for engineering purposes-AS 1289(Australian Standard, 2000).

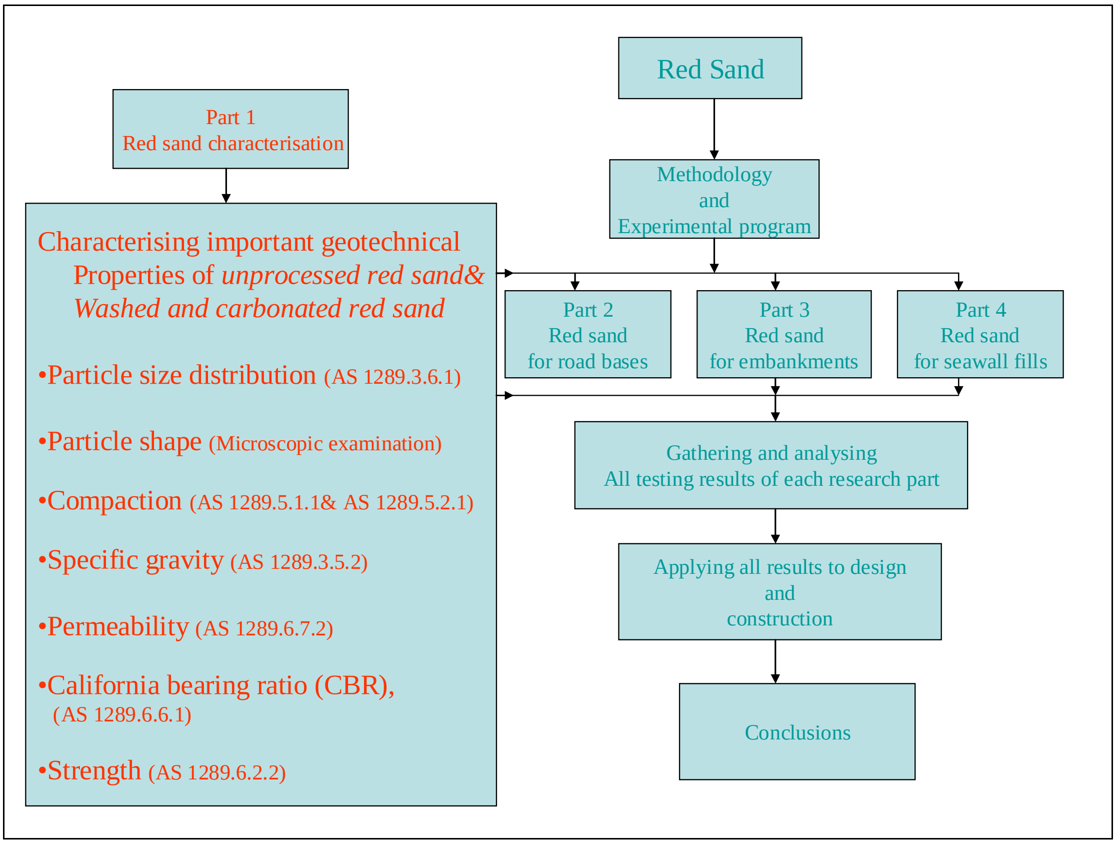

Figure 3.4 The methodology of red sand characterisation

3.3.1 Particle size distribution

Particle size distribution of unprocessed red sand and washed and carbonated red sand were determined by using a sieve analysis test procedure in accordance with the Australian standard-AS1289.3.6.1(Australian Standard, 1995). Following this standard, the particle size distribution was carried out in three separate stages, the coarse (nominal size of 60 mm to 20 mm), intermediate(nominal size of 20 mm to 6 mm), and fine particles (nominal size of 6 mm to 2 mm). However, it was obvious that both types of red sands do not contain particles larger than 4.75mm, therefore the sieves used had to be smaller not complying with the standard of AS1289.3.6.1, The sieve sizes used for this study were 4.750 mm, 2.360 mm, 1.180 mm, 0.600 mm, 0.425 mm, 0.300 mm, 0.150 mm and 0.075 mm.

Figure 3.5 Particle sieves and a sieve shaker machine

Firstly, the red sand sample was prepared by washing on the 75 μm (micro-metre) sieve. This process involved addition of water, agitating and washing on the sieve until the water which went through the sieve became clear. This means most of the finer materials (less than75 μm) were washed through the 75 μm sieve. The coarse red sand (larger than 75 μm) was collected and then placed in an oven at 105 Celsius to dry overnight. Secondly, the red sand sample was allowed to cool down to room temperature after being taken from the oven. The dried red sand was placed in a sieve set, which from the largest sieve(4.750 mm) on top to the smallest sieve (75 μm) at the bottom. The sieve set was mounted and shaken on a mechanical sieve shaker, as shown in figure 3.5, for 15 minutes, approximately. The retaining masses of the particles in each sieve were determined.

In this study, a total of 5 separate sieve analyses were performed on samples obtained at different times from the same source, the Kwinana refinery, to ensure that the red sand property was constant among batches produced. The five sieve analysis results were then averaged to give a representative gradation of the red sand.

3.3.2 Particle shape

Only the particle shape of unprocessed red sand was investigated because in terms of coarse particles, unprocessed red sand and washed and carbonated red sand are not very different depending on the production process. Consequently, the particle shape of unprocessed red sand could be representative of both red sand types.

Unprocessed red sand samples were subjected to microscopic examination in order to characterise their particle shape. A modern optical microscope which has a digital camera was utilised. The high optical microscope (OM) at the Centre for Material Research (CMR) of the Department of Physics, Curtin University of Technology, was used to examine the particle shape of red sand. This microscope has the significant advantage of digital image capture allowing data transfer and the added convenience of further analysis using image processing software installed on the microscope computer. Several imaging modes in transmitted and reflected light are available. This method was focused on pictures magnified 50 times for red sand and Perth sand to make comparison.

Figure 3.6 The optical microscope used in this study

3.3.3 Compaction

Two methods of the compaction test are used for engineering purposes; the standard and the modified compaction test. The test procedures are mainly different in the number of blows delivered to soil layers. This study investigated the compaction characteristics of unprocessed red sand and washed and carbonated red sand by using both the modified compaction and the standard compaction tests in accordance with Australian standard AS 1289.5.1.1(Australian Standard, 2003a) and AS 1289.5.2.1(Australian Standard, 2003b),respectively.

The standard compaction method uses a 50mm diameter hammer with a mass of 2.7 kg. The soil is compacted in a mould 115 mm in height and 105 mm in diameter. The samples are placed in a mould separated into 3 layers. The rammer falls freely through a drop height of 300 mm delivering compactive effort of 7.94 Joules per impact. 25 blows for each of the three layers are delivered totalling to 596 k-Joules/m^3.

The modified compaction method has a 50 mm diameter hammer which has a mass of 4.9 kg. On a total of five layers of soil, the rammer drops from a height of 450 mm delivering a compactive effort of 21.62 Joules per impact. Twenty five blows for each layer are delivered totally to 2703k-Joules/m^3, approximately four times the applied load on the standard test. The mould used is the same mould as the standard compaction. Veinier calliper measurements showed slight variations in mould dimensions due to manufacturing inconsistency. Both the modified and the standard compaction methods are performed to obtain two different optimum dry densities of the soil.

Figure 3.7 The compaction test equipment used

3.3.4 Specific gravity

Specific gravity tests in accordance with Australian standard-AS1289.3.5.1 (Australian Standard, 2006) were performed.

The specific gravity test procedure performed for both types of red sand was the procedure for materials which have particle size as 2.36 mm and smaller. The standard preparation (oven drying) was used. Red sand was poured into a volumetric flask by means of a funnel. The flask was washed by acetone dried and weighted and then filled to 2/3 of its volume with water and left for 24 hours. The flask was filled to the desired volume and a vacuum pump (see figure 3.8) was used in an attempt to remove the air voids in the water; the vacuum was applied for approximately 30 minutes. However, due to the unappropriated air pressure (approximately 10kPa) the air bubbles were seen to rise to the surface of the meniscus but did not escape from the water surface.

Figure 3.8 The vacuum pump application used

Hence, in an attempt to obtain a more accurate result, several modifications were performed. Boiled water was poured into the flask, as boiling water would be rid of air bubbles, and of leaving the flask for the recommended 24 hours of specification, in this study, it was left over 7 days for the water to completely soak in the red sand free of voids. The vacuum pump was then applied. In comparison to the previous attempt, this method only drew a small amount of bubbles to the meniscus indicating minimal air void.

The samples were then placed in a controlled temperature bath until it reached the specific temperature, in this case approximately 17 to 20 Celsius. Specific temperature correction applies at different temperature. The correction factor is given in the specifications.

3.3.5 Permeability

In this study, the Australian standard-AS1289.6.7.2 (Australian Standard, 2001b) was performed to determine the permeability of both red sand types by means of a falling head test. The falling head apparatus used is illustrated in figure 3.9. Red sand was first compacted to 95% maximum dry density and 100% optimum moisture content of both the modified compaction and the standard compaction. This was done in an attempt to simulate the practical condition use of red sand. The mould was then removed and positioned on a special base plate containing an outlet. At the top, a porous stone was placed to ensure even water distribution within the mould. The edges of the porous stone and the outer perimeter of the mould were lined with petroleum gel, as a wax replacement, to prevent water leaking out of the mould. Figure 3.10 shows the setup of compacted red sand in the permeability test mould.

The base of the mould contained an inlet pipe. Water was allowed to enter the compacted sample until it was fully saturated. The level of saturation could be observed by a separate "water level" gauge next to the apparatus. The compacted sample took approximately 4 hours to reach saturation and to be certain it was in a full saturated condition, it was left overnight.

The head was maintained by allowing the tap to open to a certain degree. Every 30 minutes, the volume of water passing through the fully saturated soil was measured in a measuring cylinder.

Figure 3.9 The falling head apparatus (two right) used

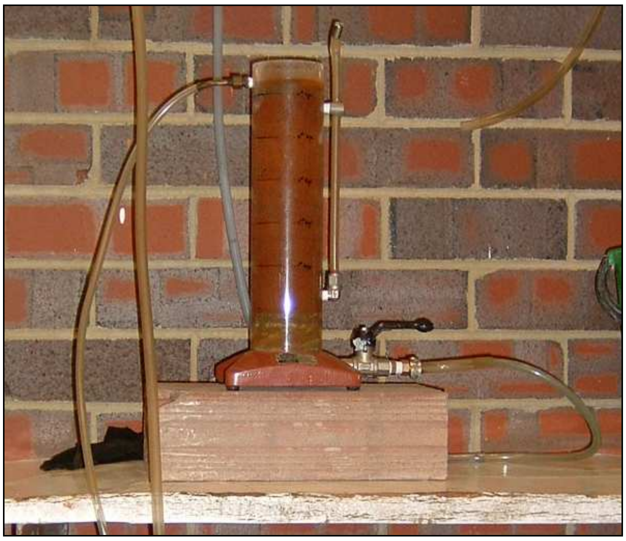

Figure 3.10 Permeability test setup for washed and carbonated red sand

3.3.6 California Bearing Ratio (CBR)

Unprocessed red sand and washed and carbonated red sand samples were subjected to CBR test procedure in accordance with Australian standard-AS1289.1.1(Australian Standard, 1998a) for un-soaked and soaked methods.

The CBR test generally starts from the compaction stage. The hammer weight used was the same as in the modified compaction test, 4.9 kg. A total of 5 soil layers with the given number of blows per layer dropping from a height of 450 mm are compacted. The number of blows applied varies, depending on the appropriate target density of soils. For both red sand types, the compaction processes were carried out to achieve 95 % maximum dry density and 100% optimum moisture content of red sand based on its compaction test results. Fifty six blows per layer were performed for both red sands. A spacer disk was first inserted before the first layer of red sand was added into the mould to temporarily fill the space under the soil so when the mould is flipped (spacer disk on top), a stem and plate and two metal surcharges may be placed in position replacing the spacer disk. The metal surcharge was applied on the compacted red sand to simulate the surcharge of pavement in a real situation.

After finishing the compaction process, the unsoaked CBR test was immediately carried out. For the soaked test, a dial gauge was placed at the top of the stem and plate. The CBR mould and the gauge were then soaked completely in water (see figure 3.11) for four days. The gauge was in position to measure the amount of swell in the red sand which would occur when it was soaked in water.

Figure 3.11 The soaked CBR setup in the soaking container

The test proceeded to be conducted on equipment with steel penetration piston with a 49.6 ±0.1 mm diameter. The stem and plate were removed to slot the piston between the surcharge disks. This stage of the test was performed on both the soaked and the unsoaked samples. The concept of CBR tests is to push the driven plunger into the soil sample and a measurement of the sample deformation can be obtained from a gauge built onto the machine. Figure 3.12 shows the penetration stage setup on Universal testing machine used.

Figure 3.12 The penetration stage of CBR tests setup

3.3.7 Strength

The strength characteristics of unprocessed red sand and washed and carbonated red sand were determined by using the standard direct shear test in accordance with the Australian standard – AS1289.6.2.2 (Australian Standard, 1998b).

Two sets of shear box tests were carried out. One on the red sand sample, which was compacted at a density obtained from standard compaction (95% maximum dry density) and another from modified compaction (95% maximum dry density). Red sand samples were prepared by adding 5% of water by weight and then they were compacted using a temper rod until they reached the target density. Figure 3.13 illustrated the red sand sample preparation in the shear box test.

The same procedure was applied to both methods. A normal load of 20kg was first applied followed by 40kg and 60kg. A lateral point load applied in the shearing plane at a rate of 1mm/s with a force equivalent to 1.405N/division.

Three dial gauges were attached to the shear box, the first gauge was a load ring to read the divisions applied on the shear box; the divisions were multiplied by the above value of 1.405N/div to obtain the force applied in the shear plane. A second gauge was used to measure the horizontal movement due to the shearing force induced. A third which was placed on top of the normal load frame was used to measure the vertical movement of the shear box. Figure 3.14 shows the direct shear machine and its setup.

(a)

(b)

Figure 3.13 (a) and (b) The preparation of compacted red sand for the shear box test

The shear box was 60mm to 100mm square, comprising two separate halves which could be moved relative to each other. A point force was applied on the upper half of the shear box by means of a loaded weight through a lever arm through a ball bearing. The horizontal displacement of the lower half of the box was the measured using a dial gauge (with respect to the upper half of the box).

Figure 3.14 The direct shear machine and setup in this study

3.4 Part 2: Red sand for road bases

3.4.1 Outline

The research methodology as shown in figure 3.15 can be divided into two sub-parts.

The first was the stabilisation of red sand. Using a soil stabilisation technique by means of pozzolanic stabilised mixtures (PSM), red sand was stabilised to improve its properties up to a level such that it could meet the requirements of base course materials. The objective of this sub-part was to establish the mixture proportion that has an unconfined compressive strength value (between 0.6MPa and 1.0 MPa) which is the range of road base material specifications for Western Australia. Red sand stabilisation was explained in the item of 3.4.2.

Once the objective of red sand stabilisation could be achieved, the verification stage began. This was the second sub-part. The commonly used base course material Hydrated Cemented Treat Crushed Rock Base, HCTCRB (crushed rocks added with 2% General Purpose-GP), which satisfies Western Australia Mainroads' specifications, was used as the control material. The bulk of the laboratory work involved testing the appropriate stabilised red sand in a Repeat Load Triaxial apparatus to determine its resilient modulus and permanent deformation characteristics and in a conventional triaxial apparatus to determine its strength characteristics was carried out to compare the results with the conventional material to evaluate its suitability.

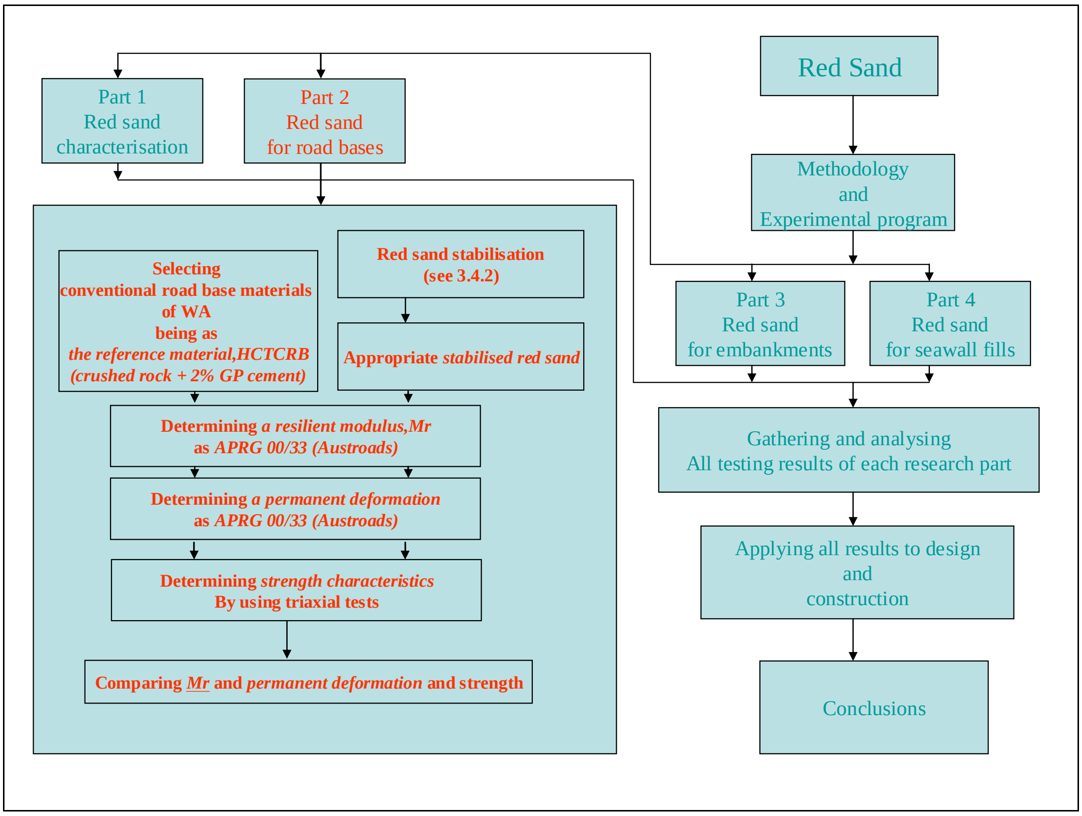

Figure 3.15 The methodology of red sand for road bases

3.4.2 Red sand stabilisation

The aim of this stabilisation technique is to use potential by-products from industries in Western Australia as stabilising materials. In this case, the PSM was red sand combined with Class F fly ash (a by-product from a coal power station), the activator, lime kiln dust (a by-product from quick lime manufacturing), and water. The use of fly ash, lime kiln dust (LKD), and water creates a pozzolanic reaction which would improve red sand properties. The appropriate proportion of red sand, fly ash, and lime kiln dust was determined in this stage, based upon compaction test results and unconfined compressive strength tests of different mixtures. The objective of this part of the study was to establish a mixture proportion that has an unconfined compressive strength value (between 0.6 MPa and 1.0 MPa) which is the range of road base material specifications for Western Australia. Alternative activators would be considered if lime kiln dust could not provide sufficient strength (details of the stabilisation process of red sand are shown in figure 3.16).

Laboratory testing for red sand stabilisation

- *Compaction test*

Modified compaction tests were performed on the red sand and fly ash mixture in the proportion of red sand to fly ash of 90:10, 80:20, 70:30, 60:40, and 50:50, following the Australian Standard, AS 1289.5.2.1-2003 (Australian Standard, 2003b). Pre-measured amounts of red sand and fly ash were mixed slowly by mixing machine at first, and then water was sprayed on gradually. When mixed thoroughly, the specimens were then compacted in a 105 mm. diameter standard mould. Figures 3.17 to 3.21 illustrate the procedures of the compaction test.

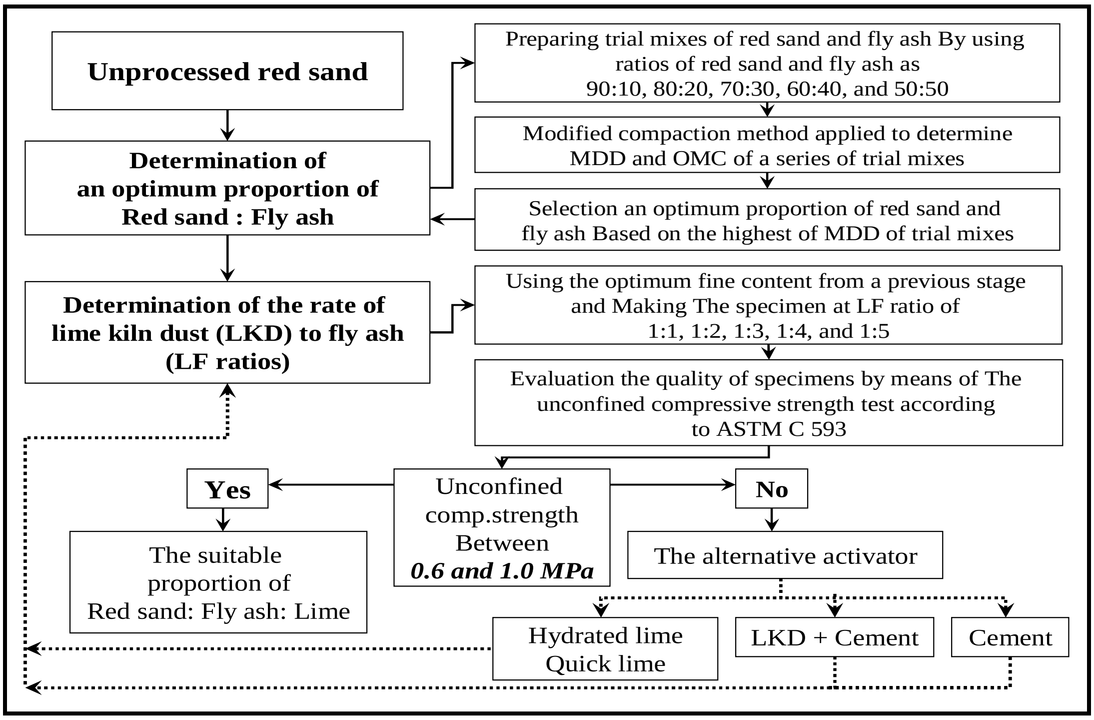

Figure 3.16 Red sand stabilisation details

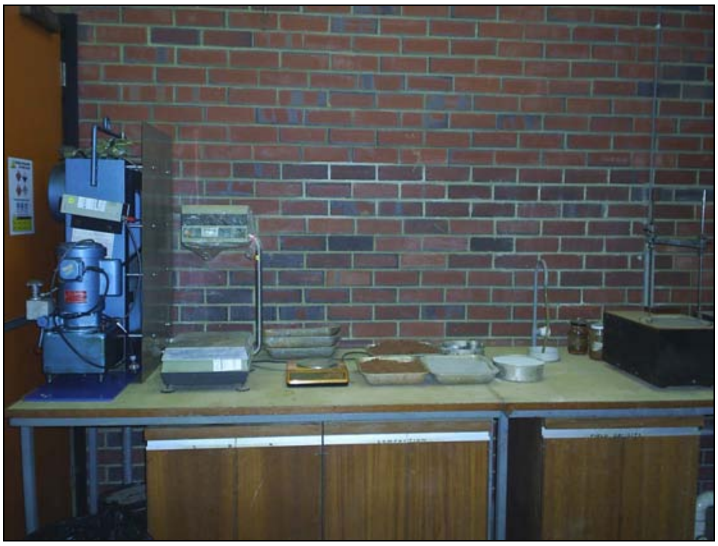

Figure 3.17 The material preparation before weighed and compacted

Figure 3.18 All mixtures in the mixing machine

Figure 3.19 The mixture after mixing

Figure 3.20 The mixture and the compaction equipment

Figure 3.21 Compacting the mixture

- *Unconfined compressive strength test (UCS)*

The unconfined compressive strength test of Main Roads Western Australia standard, WA 143.1 was followed with a strain rate of 1.0 mm./min. The tests were carried out on specimens consisting of varying mixtures of red sand, fly ash, and lime kiln dust (in various fly ash and lime kiln dust ratios, LF ratios, of 1:1, 1:2, 1:3, 1:4, and 1:5) cured for 7 days, having a density condition at maximum dry density and an optimum water content of the optimum ratio of red sand and fly ash. Following ASTM C 593-95, mixtures were compacted in a cylindrical mould 105 mm in diameter, 115.5 mm in height, and in five lifts of equal height as a modified rammer to achieve a specific unit weight for specimen preparation. After compaction, the specimens were extruded with a hydraulic jack, sealed with plastic wrap, and placed in the oven at a temperature of 38 Celsius for a curing time of 7 days. Figures 3.22 to 3.26 show testing procedures of the unconfined compressive strength test.

Figure 3.22 A sample of the mixture after compaction

Figure 3.23 Extruding the compacted sample

Figure 3.24 Samples of all LF ratios before curing in the oven

Figure 3.25 Samples in the controlled temperature oven for a 7-day curing

Figure 3.26 The Universal testing machine with the sample for UCS testing

3.4.3 Verification of red sand stabilisation

The objective of the verification is to investigate whether appropriate stabilised red sand could be a road base material or not by comparing the resilient modulus, the permanent deformation, and the strength characteristics of such red sand with those of the reference material.

Details of the reference material are described in this section and a series of laboratory tests of which the stabilised red sand and the reference material were subjected are explained in terms of detail and testing procedures.

Laboratory work for verifying stabilised red sand

Laboratory work in this stage involved testing the stabilised red sand in a repeat load triaxial apparatus to determine its resilient modulus, permanent deformation, and strength characteristics, compared with the characteristic of conventional materials for road bases used in Western Australia.

- *Specimen preparation*

All specimens at this stage were prepared based upon the optimum proportion of red sand, fly ash, and lime kiln dust which had been established in the stabilisation stage. Mixtures were oven dried over 24 hours to control the accuracy of their dry mass and allowed to cool down before being mixed with the appropriate optimum water content. The mixing procedure consisted of adding water having a percentage of optimum water content, based upon the dry mass of red sand including fly ash, into red sand and curing for 4 hours. Then fly ash and lime was added based on quantities of the optimum proportion and mixed in the mixing machine for 5 minutes or until the mixture became uniform in colour and texture. It was then compacted, using a modified compaction method in a standard mould 100 mm in diameter and 200 mm in height. Compaction was achieved with 25 blows of a 4.9 kg rammer at a 450 mm drop height in 8 layers. To assure a good bond between the layers, each layer had to be scarified to a depth of 6 mm before the next layer was compacted. After compacting, the weight of each specimen and mould was determined and the specimen was carefully removed from the mould. Immediately, after the specimen was removed from the mould, it was reweighed and wrapped in plastic to prevent loss of moisture and placed in a forced-air circulation oven maintained at a temperature of

38 Celsius for a 7-day curing period. Figure 3.27 shows the stabilised red sand sample for resilient modulus tests.

Figure 3.27 The stabilised red sand sample for the resilient modulus test

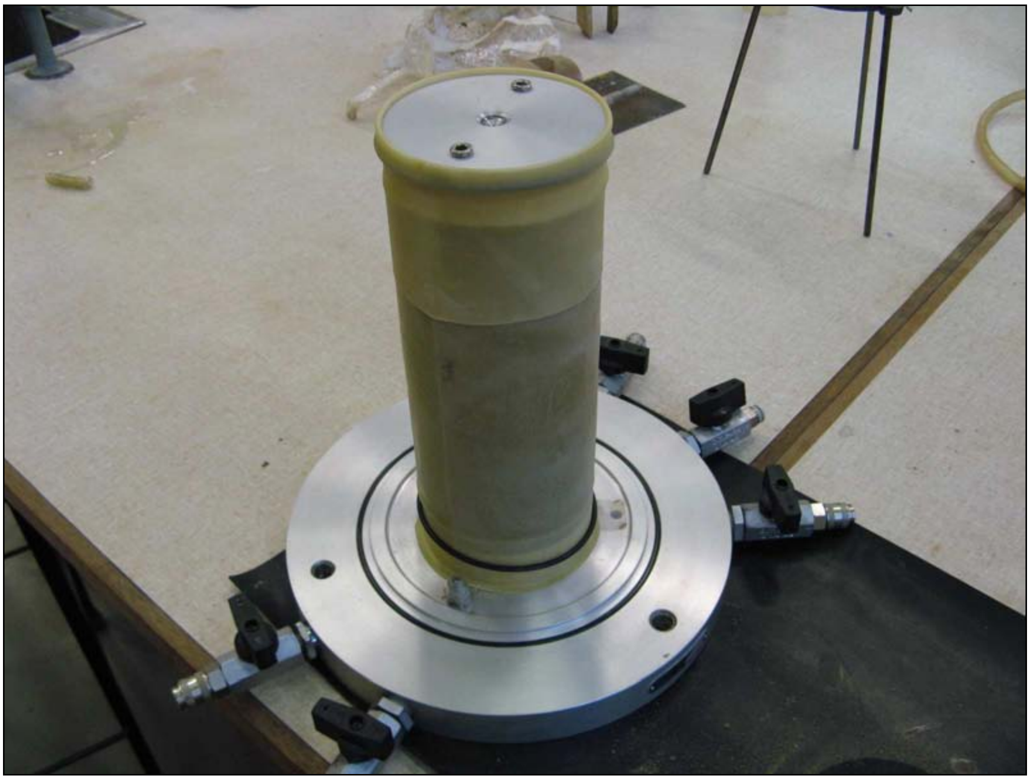

Figure 3.28 The stabilised red sand sample setup before resilient modulus testing

- *Resilient modulus tests*

The standard method of Ausroads APRG 00/33-2000 (Voung & Brimble, 2000) for Repeated Load Triaxial Test Method was followed for resilient modulus testing and permanent deformation testing. The UTM-14P digital servo control testing machine which has an ability to conduct both resilient modulus testing and permanent deformation testing was used in the Geomechanics Laboratory, Department of Civil Engineering, Curtin University of Technology. Figure 3.29 shows the apparatus to perform the testing process.

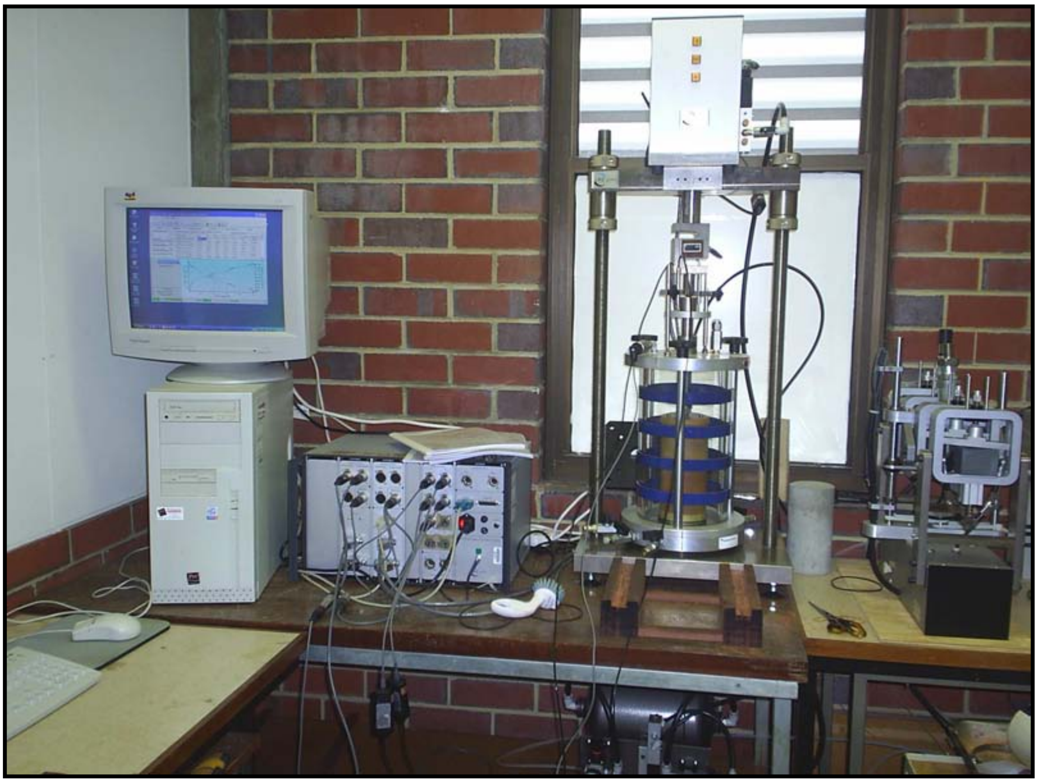

Figure 3.29 The triaxial test machine used in this study

The specimens were placed within the triaxial cell and positioned between the base plate and crosshead of the testing machine. The dynamic axial stress came from a feedback-controlled high pressure air actuator capable of accurately applying a stress pulse following the acting stress of the standard. A confining pressure was generated by a closed loop controlled actuator to simulate the lateral pressure acting on surrounding materials as would occur in a road. The confining pressure was applied by air pressure. The machine conveyed a vertical dynamic force of rectangular waveform with a period of 3 secs and a load pulse of 1 sec duration, in accordance with the standard requirements and is demonstrated in Figure 3.30.

The load cell, the confining pressure, and the external linear variable differential transducer (LVDT) on the top of the triaxial cell, which was used to measure deformations over the entire length of the specimen, were measured by a control and data acquisition system (CDAS) which provided control signals, signal conditioning, and data acquisition. The CDAS communicated with the computer which provided interfacing with the testing software and stored the raw test data. These enabled the resultant stress and strain in the sample to be determined.

Following this standard, the specimens were applied sequentially by a difference of the 65 stress stages (see figure 3.31) to check the elastic condition of each specimen throughout multiple loading stress stages. This process simulates the complicated traffic loading acting on pavement. Before performing the resilient modulus process, a pre-conditioning stage was carried out to allow the end caps to bed into the specimen and the applied stresses and resilient strains to stabilise under the imposed stress condition, thus 1000 loading cycles of pre-conditioning were used and for each stress stage after pre-conditioning, 200 loading cycles were applied to the specimens.

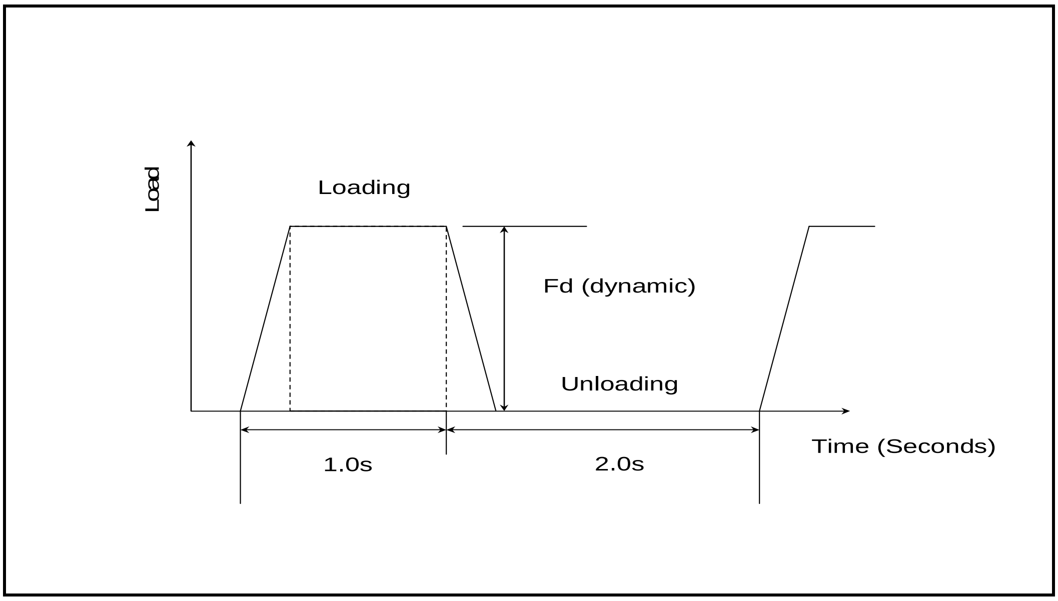

Figure 3.30 Illustration of the vertical force waveform

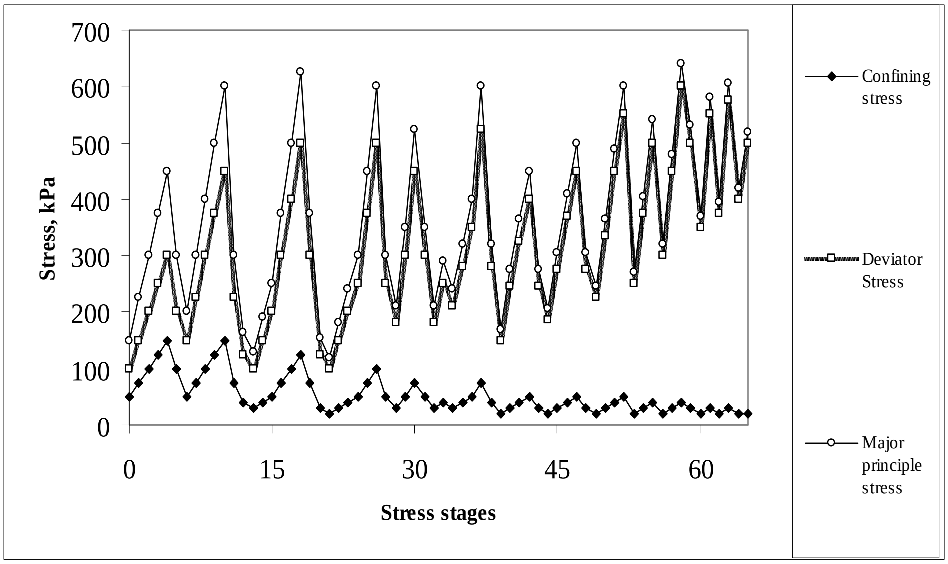

Figure 3.31 Applied stresses and its stress stages of the resilient modulus tests

- *Permanent deformation tests*

New specimens were prepared following the same method as the resilient modulus specimen, described in the sample preparation item. Permanent deformation testing was calculated in accordance with Austroads – APRG 00/33 standard. In this testing, the specimens were loaded with three stress stages, each involving 10,000 cycles at a stress condition of specific dynamic deviator stress and static confining pressure as shown in table 3.1.

Table 3.1 Stress levels for permanent deformation of base materials following Austroad-APRG 00/33 standard

Permanent Deformation Stress Levels		
Stress Stage Number	Base	
	Confining pressure, σ_3 kPa	Cyclic deviator stress, σ_d kPa
1	50	350
2	50	450
3	50	550

- *Static triaxial tests*

Drained triaxial compression tests were conducted to determine the shear strength parameters (c and ϕ) of stabilised red sand. The specimens were tested under the unsaturated condition (at the compaction condition) and suctions were not measured during triaxial testing. In these tests, the specimen response was measured at three different constant confining pressures: 50 kPa, 100 kPa, and 150 kPa. These tests were carried out using the same triaxial equipments and systems devoted to the measurement of resilient modulus and permanent deformation as previously described.

Reference material

In the verification stage of this part, Hydrated Cemented Treated Crushed Rock base(HCTCRB) was used as the reference material. In this item, HCTCRB was described. Additionally, crushed rock which was used to produce HCTCRB was explained. For only the reference material, a set of laboratories was established to quantify crushed rock that was selected from a local quarry and to determine resilient modulus characteristics and permanent characteristics of HCTCRB

- *Hydrated Cemented Treated Crushed Rock Base (HCTCRB)*

Hydrated Cemented Treated Crushed Rock Base (HCTCRB) is manufactured by blending 2 % cement, which shall be the General Purpose (GP) or Portland cement following the standard of AS 3972-1977(Australian Standard, 1997; Australian Standard AS 3972-1997, 1997; Main Roads Western Australia, 1997), with a standard crushed rock base (Main Roads Western Australia, 2003). HCTCRB is mixed and stockpiled in the range of -1.0% to +2.0% of the optimum moisture content of the untreated crushed rock base as obtained by MRWA Test Method WA 133.1(Main Roads Western Australia, 1997) during the initial hydration of a 7-day period.

- *Crushed rock*

The crushed rock used in this study was obtained from a local Gosnells Quarry. Crushed rock samples were collected randomly from a stockpile area and kept in sealed plastic containers. Samples were re-checked, at the Department of Civil Engineering, Curtin University of Technology, in the laboratory as to their important properties in accordance with the Crushed Rock Base (CRB); Basecourse

Specifications (Main Roads Western Australia, 2003). Table 3.2 illustrates the testing program of crushed rock used to quantify the important properties for comparison with the specifications. Figure 3.32 shows the crushed rock used in this study.

- *Cement*

The cement used was the bagged cement product of Cockburn Cement(Cockburn cement, 2006b) of the type of General Purpose Portland Cement – type GP. The general specifications of this cement are shown in Table 3.3.

Table 3.2 The testing program of crushed rock.

Test Methods*	Tests	Specification
WA 120.2	Liquid Limit, LL	<25
WA 121.1	Plastic Limit, PL	N/A
WA 122.1	Plastic Index, PI	N/A
WA 123.1	Linear Shrinkage, LS	0.4-2.0
WA 216.1	Flakiness Index, FI	<30
WA 140.1	Max. Dry Compressive Strength, MDCS	> 1700 kPa
WA 220.1	California Bearing Ratio, CBR	80
WA 133.3**	Modified Compaction	N/A

* test methods in accordance with MRWA Test Method (Main Roads Western Australia, 2006)

** For establishing the compaction curve for the optimum moisture content (OMC) and the maximum dry density (MDD), HCTCRB samples for triaxial tests then were made at 100% OMC of the crushed rock.

Figure 3.32 The crushed rock sample used in this study

Table 3.3 General specifications of the cement used (Cockburn cement, 2006b).

Parameter	Method	Units	Typical	Range	AS3972-1977 limits
Chemical Analysis					
SiO2	XRF	%	20.7	19.5-21.6	-
Al2O3	XRF	%	4.8	4.5-5.3	-
Fe2O3	XRF	%	2.7	2.3-3.1	-
CaO	XRF	%	63.8	62.2-65.5	-
MgO	XRF	%	2.1	1.5-2.8	-
SO3	XRF	%	2.5	2.0-3.2	3.5% max
LOI	AS2350.2	%	1.8	0.5-2.7	-
Chloride	ASTM C114	%	0.01	0.01-0.02	-
Na2O equiv.	ASTM C114	%	0.50	0.45-0.65	-
Fineness Index	AS2350.8	m^2/kg	400	350-450	-
Normal Consistency	AS2350.3	%	29.5	28.0-30.0	-
Setting Times					
Initial	AS2350.4	mins	120	90-150	45mins min
Final		mins	190	135-210	10 hrs max
Soundness	AS2350.5	mm	1	0-2	5 mm max
Compressive Strength					
3 days	AS2350.11	MPa	38	33-40	-
7 days		MPa	48	41-52	25MPa min
28 days		MPa	60	53-68	40MPa min

Laboratory testing for the reference material

The test program consisted of both static and repeated loading triaxial tests. The static tests were carried out to establish the cohesion (c) and the internal friction angle (ϕ) of HCTCRB including establishing the Mohr-Coulomb failure envelope. Repeated loading tests were performed to establish the relationships between the applied stress conditions and the resilient modulus values and the permanent deformation behaviours of HCTCRB.

- *Specimen preparation*

All tested HCTCRB samples were prepared based upon 100% OMC of the crushed rock. The mixing procedure consisted of adding 2% GP cement (dry masses) to the wet crushed rock having the 100% OMC condition and mixing then for 10 minutes or until the mixture became uniform in colour and texture. The mixture then was kept at room temperature in sealed plastic bags for a 7-day period. After that, the mixture was then re-mixed in the same mixing machine at least 10 minutes. The compaction processes were then carried out, using a modified compaction method in the standard mould 100 mm in diameter and 200 mm in height. Compaction was achieved with 25 blows of a 4.9 kg rammer at a 450 mm drop height in 8 layers. To assure a good bond between the layers, each layer had to be scarified to a depth of 6 mm before the next layer was compacted. After compacting, the weight of each specimen and mould was determined, and the specimen was carefully removed from the mould. Immediately, after removal, it was reweighed and wrapped in plastic to prevent loss of moisture and left overnight before being transferred to the bottom platen of the triaxial cell. The top platen was placed on the specimen and the rubber membrane was placed over the specimen and both platens, and finally sealed the sample system by o-rings at top and bottom. Figures 3.33 to 3.38 show HCTCRB sample preparation.

Figure 3.33 Crushed rock after mixed with cement

Figure 3.34 HCTCRB hydration in a plastic bag for 7 days

Figure 3.35 HCTCRB, which has the hydration process for a 7-day, after re-mixing

Figure 3.36 HCTCRB and compaction equipments

Figure 3.37 HCTCRB after compaction

Figure 3.38 HCTCRB after de-moulding

- *Resilient modulus, permanent deformation and strength*

All tests for HCTCRB were carried out with the same triaxial equipment and following the testing procedures as those for the stabilised red sand.

3.5 Part 3: Red sand for embankments

3.5.1 Outline

The methodology and experimental program of red sand for embankments in this study based on the assumption that unprocessed red sand were stabilised by means of Pozzolanic stabilisation technique before uses as an embankment material. The sample appropriate proportion of unprocessed red sand, fly ash, and lime kiln dust (section 3.4.2) was subjected to determine the important characteristics for embankments by a series of tests.

The following tests were selected as they returned results that were applicable to embankment design. The experiments focused on strength, permeability, and consolidation. All tests were conducted on specimens of the representative stabilised red sand as follow:

- Strength
  Consolidated drained triaxial tests
- Consolidation
  Triaxial consolidation tests
- Permeability
  Indirect method from consolidation parameters

Figure 3.39 shows the experimental program of red sand for embankments

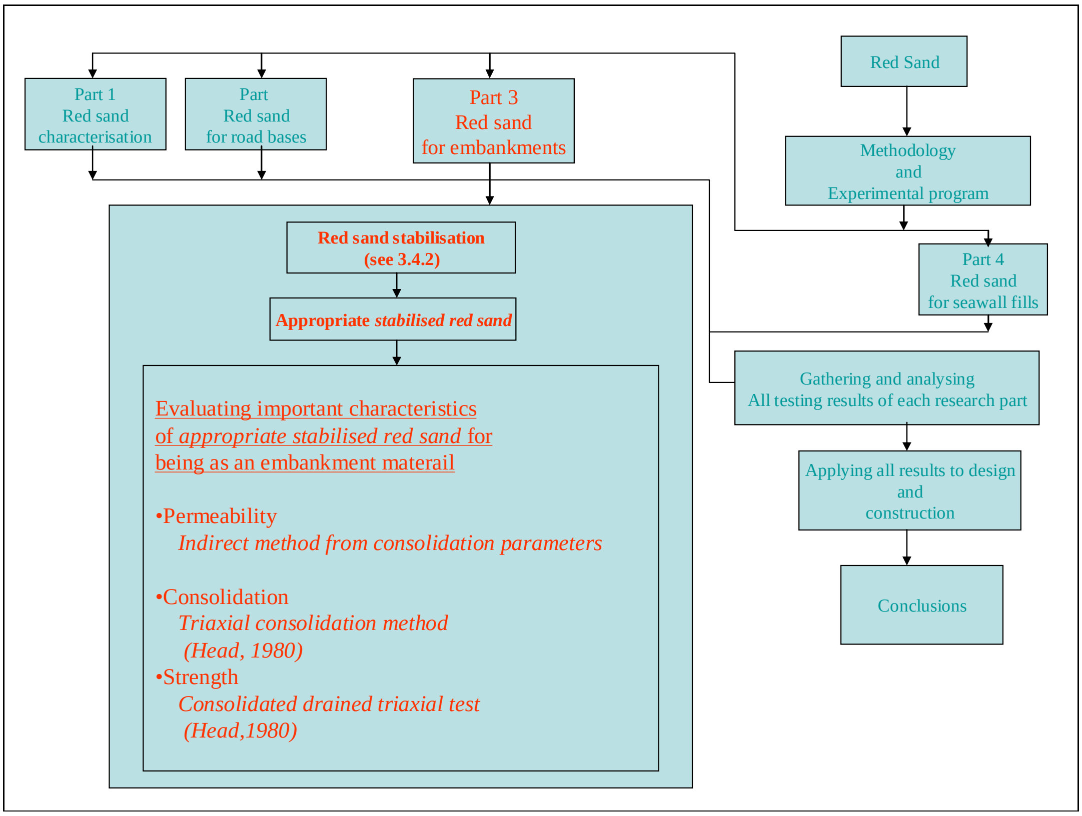

Figure 3.39 Experimental programs of red sand for embankments

3.5.2 Laboratory testing for red sand for embankments

Strength

For stabilised red sand for embankments, conventional consolidated drained triaxial tests were used to determine strength characteristics. These tests were conducted by using the conventional triaxial testing machine which differs from the static triaxial test in red sand for road bases.

At first, stabilised red sand samples derived from the optimum mixture between unprocessed red sand, fly ash, and lime kiln dust were prepared in a plastic tube of 38 mm diameter and 76 mm in height. All specimens at this stage were prepared based upon the optimum proportion of red sand, fly ash, and lime kiln dust established in the stabilisation stage. The mixtures also were oven dried over 24 hours (to control exactly the dry weight) before being mixed with the appropriate optimum water content. Mixing all mixtures in the mixing machine at least 5 minutes or until the mixture became uniform in colour and texture. The mixture was then compacted using a temper rod to achieve target density. After compacting, the weight of each specimen and a plastic tube mould was determined, and the specimen was wrapped with the plastic to prevent loss of moisture and then, was placed in a forced-air circulation oven maintained at a temperature of 38 Celsius for a 7- day curing period. Figure 3.40 to figure 3.42 shows some pictures from this sample preparation.

Figure 3.40 Specimen after compacting in a plastic tube mould

Figure 3.41 Wrapped specimens before the curing process

Figure 3.42 Specimens in the oven for curing

After the sample preparation process, the stabilised red sand was carefully placed on the soaked porous disc which was mounted on the pedestal. A second saturated porous disc, with excess surface water from the disc, on the top end of the sample was operated then. For these tests, a side drain was not used. A rubber membrane (thickness 0.2 mm) was placed over the sample and then, a set of o-rings were fitted to the pedestal and the top loading cap. Figure 3.43 shows the sample after placed on the pedestal and covered with the rubber membrane. After that the triaxial cell was assembled and transported to the triaxial testing machine. Figure 3.44 shows the triaxial test setup before beginning of test procedures.

Figure 3.43 The sample for triaxial tests

Figure 3.44 The triaxial test setup

The saturation process was began by applying back and cell pressure increasingly at the effective pressure (the different pressure between cell pressure and back pressure) of 30 kPa . A series of these tests were used a back pressure up to 500 kPa and cell pressure up to 530 kPa and this process was carried on until the B-value reached at least 95%. Upon completion of the back pressure saturation, isotropic consolidation processes were conducted at effective confining pressures of 50 kPa, 100 kPa, and 150 kPa and a consolidation period in the range of 180 minutes to 360 minutes was allowed for the sample to have enough time to fully dissipate the generated pore pressure and reach primary consolidation, as revealed by the consolidation graph plotted between the volume change and time.

Triaxial compression (shearing) was performed on the saturated specimen previously consolidated to a given effective confining pressure under strain-controlled condition at the selected strain rate of 0.25 mm/min. In these tests, the cell pressure was applied by wind pressure acting to water in the triaxial cell and the back pressure was operated by the GDS Ltd's pressure controller as shown in figure 3.45. The test was manual-controlled and involved readings recorded by two persons (one for the loading-proving ring reading and another for the volume change reading from the pressure controller).

Consolidation

Triaxial consolidation was designed to evaluate the compressibility of the stabilised red sand for embankments in this study. Due to stabilised red sand being a cementitious material, it is not easy to make it reach a fully saturated condition. Consequently, a traditionally one-dimensional consolidation test is not suitable for this material because stabilised red sand cannot be fully saturated by only soaking under water in the common consolidation unit.

Figure 3.45 The pressure controller used

The saturation of applying a back pressure following the triaxial test procedure was performed on the stabilised red sand sample, which was prepared similar to the sample for the conventional triaxial tests, until the sample had a B-value of 95%. These tests were carried out using the same equipment as for the conventional triaxial tests conducted for stabilised red sand for embankments in the previous section. After the saturation process, triaxial consolidation was conducted straight away. A series of isotropic stresses (up to 800 kPa) were applied to the sample. Drainage of excess pore water took place from the drainage line at the bottom of the pedestal. In each applied isotropic pressure, the volume of water draining out of the sample during consolidation (equal to the sample volume change for a saturated sample) was recorded from the GDS pressure controller together with time involved in of this process. Both data were plotted in forms of the volume change against with square-root time (minutes) and then theoretical 100% consolidation, t_{100} was determined (Head, 1980).

Permeability

In this part, the permeability in terms of the hydraulic conductivity (the coefficient of permeability), k was determined by an indirect method. The direct method of determining of the coefficient of permeability in accordance with the Australia standard (the falling head and the constant head methods) could not be applied to the stabilised red sand because of the saturation problem. Consequently, an indirect method of determining the hydraulic conductivity of stabilised red sand was employed for this section.

To find the permeability or hydraulic conductivity (*k*) of soils from their relative one-dimensional consolidation test results (Terzaghi, 1943), the following equation was considered:

$$k = C_v m_v \gamma_w = C_v \gamma_w \left(\frac{\Delta e}{\Delta p (1 + e_{av})} \right) \qquad (3.1)$$

Where:

k = Hydraulic conductivity of the soils (m/min)

C_v = Coefficient of consolidation

m_v = Coefficient of compressibility (m^2/MN)

γ_w = Specific weight of water, 9810 N/m^2

p = Change in pressure experienced by the soil (MPa)

Δe = Total change of void ratio caused by a stress Increase of Δp

e_{av} = Average void ratio during consolidation

Although, in this section, the one-dimensional consolidation could not be performed, the important consolidation parameters relating to the equation could be derived from the triaxial consolidation following the method which proposed by Head (1980).

3.6 Part 4: Red sand for seawall fills

3.6.1 Outline

The methodology and testing program of this part is based on the assumption that washed and carbonated red sand behaves as a backfill material of a retaining structure (a seawall) and as a core material of a breakwater structure (a seawall). The methodology was designed to evaluate the important engineering characteristics of such red sand as a backfill material and a core material.

Generally, following design aspects of a retaining wall structure, the permeability, consolidation, and strength characteristics of a backfill material need to be known and understood because the overall stability of performance of the structure strongly depends upon the characteristics. Washed and carbonated red sand was subjected to permeability tests, consolidation tests, and strength tests (by means of consolidated drained triaxial tests) to quantify its permeability, consolidation, and strength characteristics. The reference material (Perth sand), usually used for a backfill material, was used to find the same properties of washed and carbonated red sand. A comparison was made to evaluate the suitability using red sand as seawall materials.

For the core material of a breakwater structure, which is normally a seawall in Western Australia, the significant parameters for this material are its unit weight (γ) and its particle dimension. The specifications from a particular construction manual were followed and comparisons were made with washed and carbonated red sand.

The research methodology of red sand for seawall fills is presented in figure 3.46 as well as the laboratory methods.

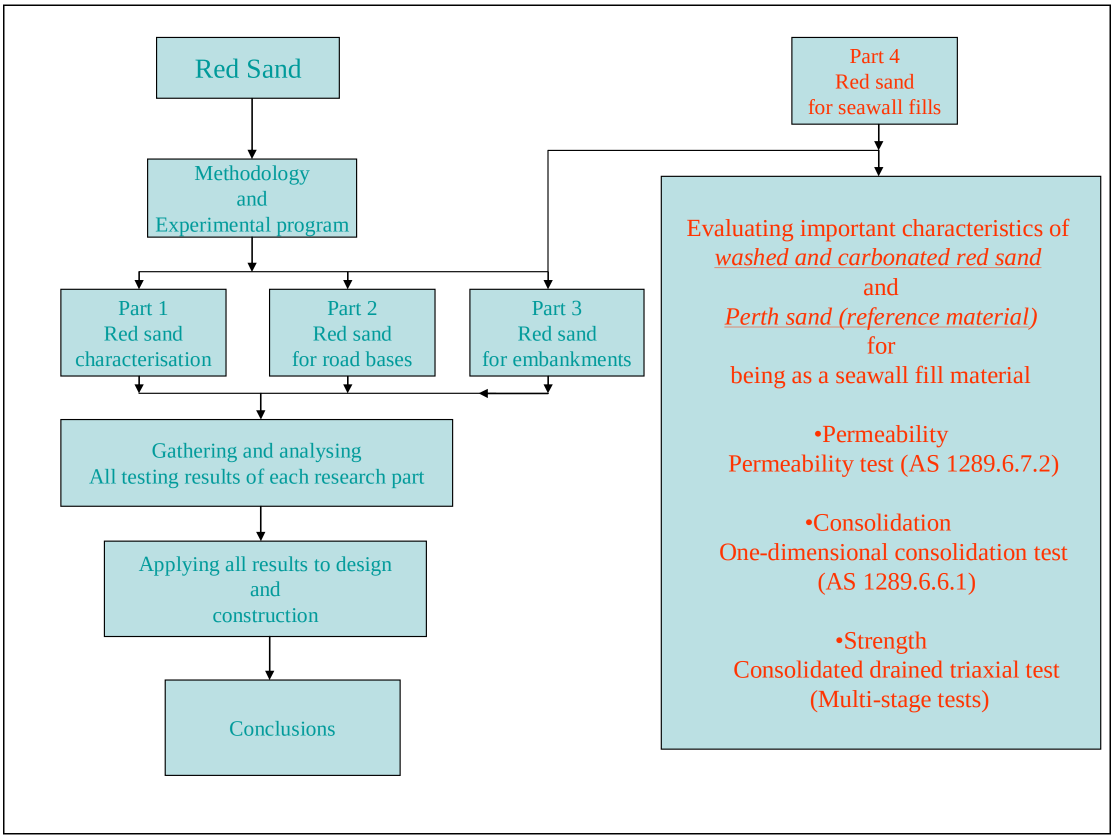

Figure 3.46 Research methodology of red sand for seawall fills

3.6.2 Laboratory testing for red sand for seawall fills

Permeability

The Australian standard-AS1289.6.7.1 (Australian Standard, 2001a) was used to determine the permeability of red sand by means of a falling head test as permeability in section 3.3.5. At this stage, the constant head apparatus illustrated in figure 3.9.

Sample preparation was different from the permeability test in section 3.3.5. First, red sand was compacted following the modified compaction method (AS 1289.5.2.1) to reach a condition of 95% maximum dry density and 100% optimum moisture content, determined from the modified compaction curve of washed and carbonated red sand. Before the compaction process, red sand was mixed with some water until reached the 100% optimum moisture content condition and then the 100% optimum moisture content red sand was kept in plastic bags for overnight. This was done to assure that representative red sand for compaction can be at 100% optimum moisture content (no absorption effect). A mould 115 mm in height and 105mm in diameter was used. It was positioned on a special base plate and a top plate containing an outlet and inlet. At the top, a porous stone was placed to ensure even water distribution within the mould. The edges of the porous stone and the outer perimeter of the mould were lined with petroleum gel as a wax replacement to prevent water leaking from the mould. After that, a set of the permeability test mould was soaked under the water for a month to simulate the condition of red sand as a backfill material of a seawall structure. Some parts of a backfill usually is under water. When the soaking period ended, a set of the permeability test mould was set up with the falling head apparatus and tests carried out in accordance with the standard by taking readings every 40 minutes interval for 5 times per test. Figures 3.47 to 3.48 illustrate the procedures and equipment of this test.

Figure 3.47 Permeability mould setup

Figure 3.48 The falling head permeability test setup

__Consolidation__

One dimensional consolidation tests were performed on washed and carbonated red sand in accordance with AS 1289.6.6.1(Australian Standard, 1998c) to evaluate the consolidation (compressibility) characteristics of the compacted red sand.

Washed and carbonated red sand was compacted in the consolidation ring using a temper rod until it reached 95% maximum dry density and 100% optimum moisture content which were determined from the modified compaction curve of washed and carbonated red sand. This was to simulate the practical conditions of such red sand as a backfill material. Figures 3.49 and 3.50 show the sample preparation of this test.

Figure 3.49 Equipment and red sand before being compacted

Figure 3.50 Washed and carbonated red sand after compaction in the consolidation unit

After sample preparation, the consolidation unit was assembled and taken to the consolidation apparatus (see figure 3.51), allowed to soak in water for a 7-day period before applying the loads. The pressure applied in this test was up to 800 kPa.

Figure 3.51 The consolidation apparatus used in this study

Strength

The strength characteristics of a backfill material of a retaining structure and a core material of a seawall structure are very important in earth pressure computation which significantly depends upon the stability and performance of such structures. To calculate the degree of lateral earth pressure, the backfill shear strength parameter, cohesion (c), internal friction angle (ϕ) and the unit weight (γ) need to be known. In particular a seawall structure, as the backfill material of a seawall tends to be filled under water; its parameters have to be determined in terms of the effective parameter. The objective of the strength test in this study is to find the shear effective stress parameters of washed and carbonated red sand which is supposed to be a backfill material of a seawall structure.

The consolidated drained triaxial test by means of the multistage test was employed to determine those parameters. The main advantage of multistage testing generally is in the saving of time and material but in this study, the multistage test was used because of the reducing effects of the sample preparation on red sand. Unlike cohesive soils, cohesionless soils (red sands) are difficult to prepare samples for testing because they fall apart very easily. A special preparation technique has to be applied. Conducting a series of tests separately as the conventional triaxial test on cohesionless soils is difficult to prepare the tested specimen in similar conditions. Only one specimen is subjected to the multistage test, the effect would be reduced.

Initially, washed and carbonated red sand was left overnight to dry out in the oven at 105 degree Celsius. The material was then cooled down to room temperature in the tightly sealed desiccators with freshly added silica crystals. Pre-determined amount of the red sand in a dry plastic container and the red sand found be more consistent by repeatedly shaking and turning upside down the container for 5 minutes. Distilled water was added then to the red sand until it reached a given amount (to get 100%OMC of washed and carbonated red sand). After that wet red sand was mixed in the mixing machine until the good mixture was gotten. The sample was kept for a 24-hour curing. The water content was determined to ensure that 100% OMC condition could be achieved.

An elastic membrane was secured on the bottom pedestal by two 0-rings and a spitted-metallic mould, with inside diameter of 38 mm and a height of 76 mm, was then seated on the bottom pedestal as depicted in figures 3.52 and 3.53.

Figure 3.52 The pedestal and equipments of sample preparation

Figure 3.53 The metallic mould with the rubber membrane setup

An important criterion during this sample preparation was the uniform distribution of void ratio within the specimen. In this regard, the moist tamping technique was strongly criticised and considered to produce the specimen with a non-uniform void ratio distribution over the height of the specimen with a dry density of 95%MDD. Pre-determined amounts of red sand were slightly tamped and carefully conducted into 10 layers, each 7.6 mm thick. After moulding the specimen, the top loading cap was carefully seated on the levelled surface and the membrane was secured by a set of o-rings. Figure 3.54 shows red sand after tamping in the mould. After that the metallic mould was carefully de-composed and the triaxial cell was assembled. Figure 3.55 shows the sample after de-moulding.

Figure 3.54 The red sand after tamping

Figure 3.55 The sample after taking off the metallic mould

After completing sample preparation, the composed triaxial unit cell was set up as for a conventional consolidated drained triaxial test. The saturation process was carried out to achieve the acceptable B-value of 95% and the tested sample was consolidated to the first (lowest) effective confining pressure of 50 kPa selected for this test. When the consolidation process was finished, the compression stage was started in the usual way with a compression rate of 0.25 mm/ min. As the test proceeded, calculating data for plotting the deviator stress and the volume change against strain was carried out. When failure was approached according to flattening out of the deviator stress/strain curve (with all corrections applied) and stopping of the volume change, the compression machine was stopped and the drainage valve was closed. The motor was then immediately reversed to reduce the axial load rapidly until it just reached zero and the corresponding axial strain reading was recorded. The testing system was stopped about 5 minutes to allow for the pore pressure to reach equilibrium before proceeding further. The next stage was continued by increasing the cell pressure and maintaining the back pressure at the same level as previously until the required effective pressure of 100 kPa could be achieved. The sample was consolidated as before and the new consolidation dimension was calculated. The second stage was still used the strain rate of 0.25 mm/min. The compression machine was winded up to re-make contact between the cell piston and the top cap and then the new datum reading was set. The compression was resumed and continued until the failure was again approached. All steps were repeated in the third stage by using the same strain rate and the effective pressure of 250 kPa. Figure 3.56 shows the multistage test setup.

Figure 3.56 The multistage triaxial test setup

CHAPTER 4

RESULTS AND DISCUSSION

4.1 Overview

This chapter presents the results and discussion of laboratory experiments performed on red sand and stabilised red sand following the methodology and experimental program of chapter 3 as follows:

- Part 1- the experimental results of unprocessed red sand and washed and carbonated red sand, which were subjected to the tests for determining the important geotechnical characteristics of particle size distribution, particle shape, compaction, specific gravity, permeability, California bearing ratio (CBR), and strength, are presented in the results. The discussion is focused on comparing the result with that of the general sand like Perth sand.

- Part 2 – has two sub-parts presented. First, the results and discussion of the stabilisation of unprocessed red sand are given. The results of a series of compaction tests and unconfined compaction tests, based on the method of selecting the appropriate proportion of red sand, fly ash, and lime kiln dust for the red sand stabilisation, are shown. The discussion on why the appropriated proportion is selected from those results. Second, the results and discussion of the appropriate stabilised red sand and the reference material (Hydrated Cemented Treated Crushed Rock Base, HCTCRB) are presented. The discussion is focused on comparing the results of resilient modulus tests, permanent deformation tests, and strength tests between the stabilised red sand and HCTCRB. This could show whether the stabilised red sand is as good equally as conventional road base material, HCTCRB, or not.

- Part 3 - the experimental results of stabilised red sand as an embankment material are presented. The results of the triaxial consolidation tests (isotropically hydraulic consolidation tests), the compression test by using consolidated drained triaxial tests, and the permeability based on the indirect method from the triaxial consolidation tests are described.

- Part 4 - the experimental results of washed and carbonated red sand as the backfill material of a seawall, and Perth sand, the reference material, are presented. The results of permeability tests, one-dimensional consolidation tests, and strength tests, by means of consolidated drained triaxial tests (multistage tests), of both materials are discussed and comparisons are made.

4.2 Part 1: Red sand characterisation

4.2.1 Particle size distribution

Generally, a sieve analysis test result is represented in terms of a gradation chart which shows the relative sieve sizes and percentages of soil masses passing through the sieve set. The particle size distributions for unprocessed red sand and washed and carbonated red sand derived from the tests in this study are shown in figure 4.1. It was found that the majority of the fractions lies within the defined sand, with a small fraction (ca 5%) being defined as silt. Moreover, based upon the sieve analysis results and the shape of the gradation curve, unprocessed red sand can be grouped in the soil group SP-SM a poorly graded sand mixture with silty soils, in accordance with the unified soil classification system (USCS). Washed and carbonated red sand can also be grouped in the soil group SP, poorly graded sand following the same classification system.

Comparison on the gradation chart between both red sands and Perth sand is illustrated in figure 4.2. It is obvious the red sand the particle size characteristic is very similar to that of Perth sand. Most fractions of the both are situated within a sand range from 2.00 mm to 0.06 mm.

The particle size distribution characteristic of soils is usually specified in construction specifications which normally depict the upper and the lower limits of the particle size distribution of a suitable material to be used for a particular construction purpose. Main Roads Western Australia has established particle size distribution specifications of base course, subbase course, and earthwork materials. Figures 4.3 and 4.4 perform the specifications and red sand particle size characteristics. Figure 4.3 shows the gradation charts of both red sands lie in the boundary of earthwork materials which means red sand could be earthwork material from the particle size distribution point of view. On the other hand, when considering both red sands for road construction materials (see figure 4.4), the results show that the red sand gradations lie out of the subbase and base material ranges. From this point, both red sands by themselves could not be subbase and base materials from the particle size perspective.

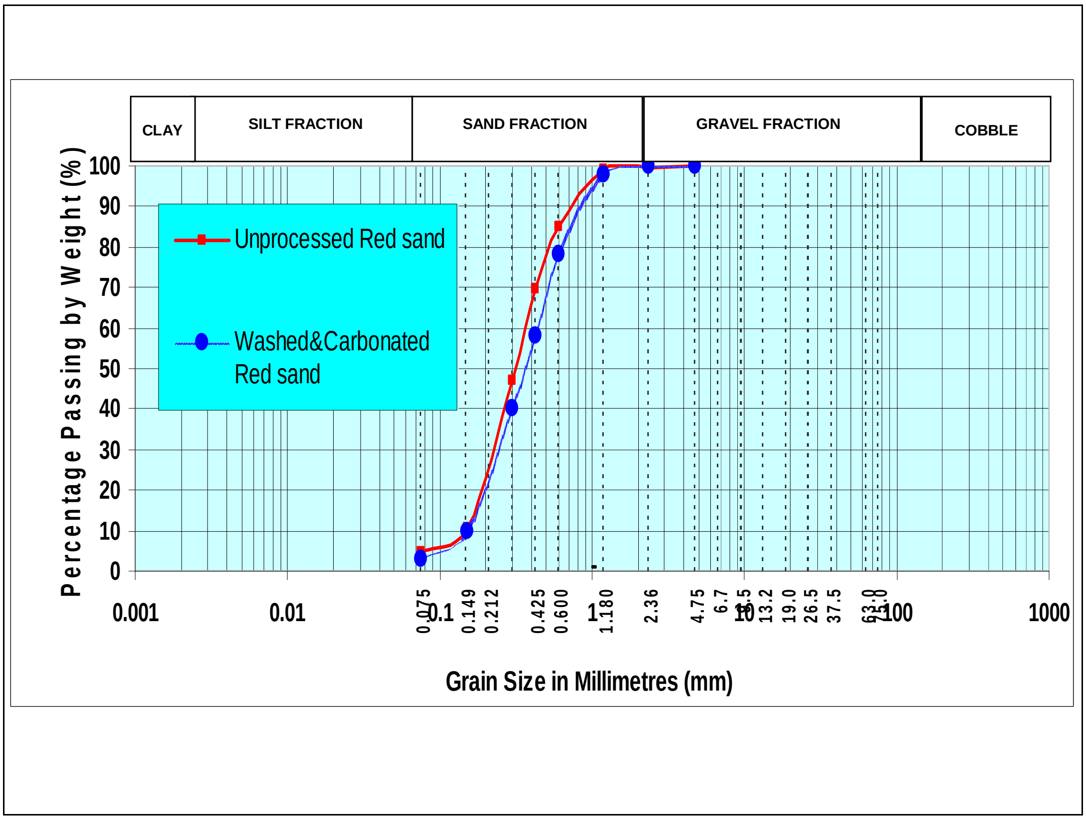

Figure 4.1 Gradation charts of both red sands

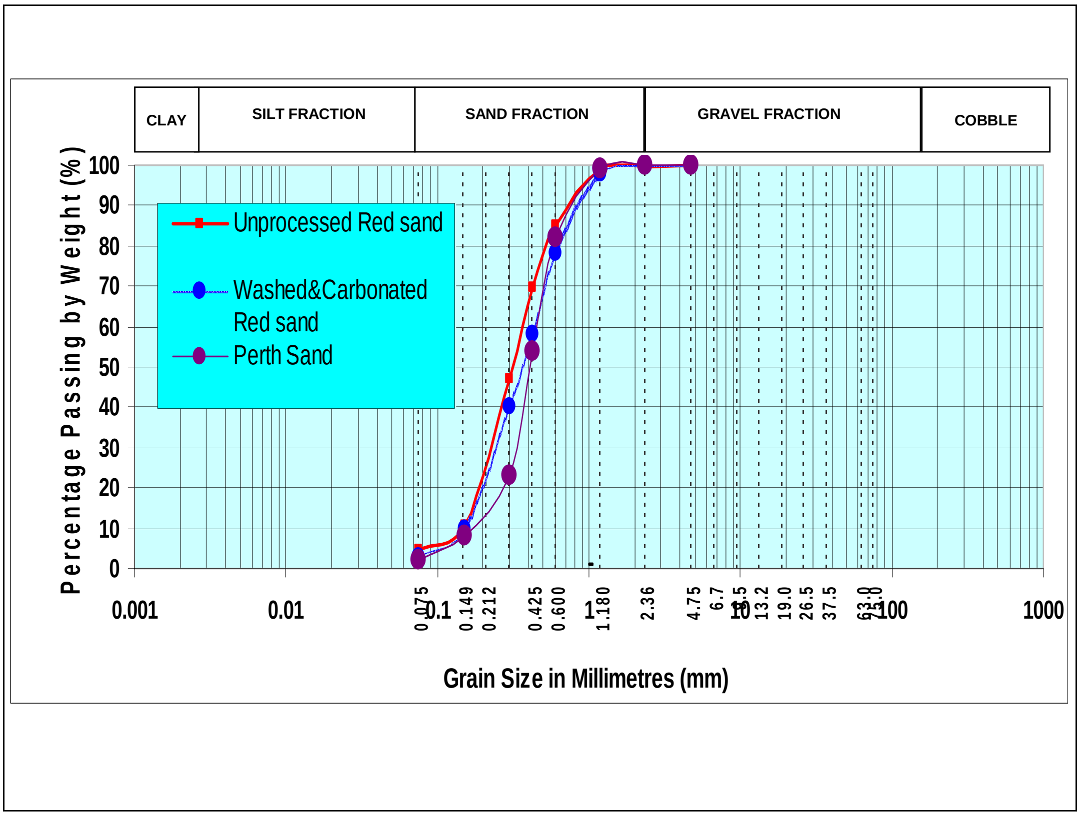

Figure 4.2 Gradation charts of both red sands and Perth sand

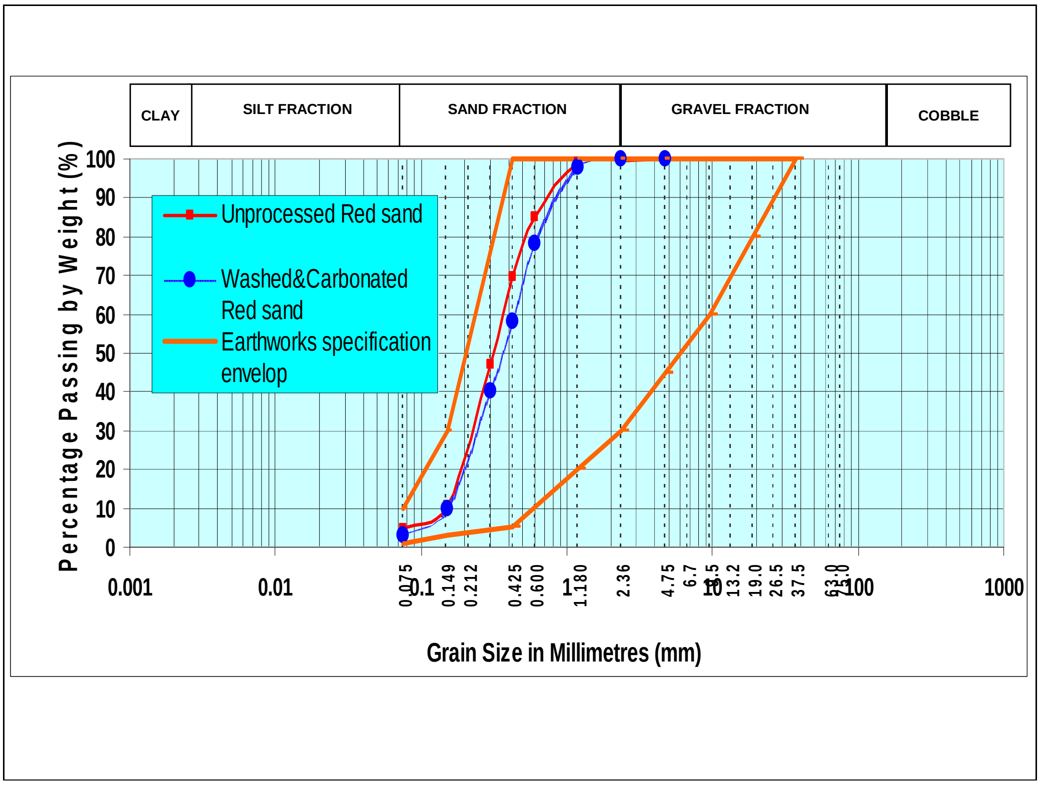

Figure 4.3 Red sand gradation charts and the particle size distribution boundary of earthwork materials

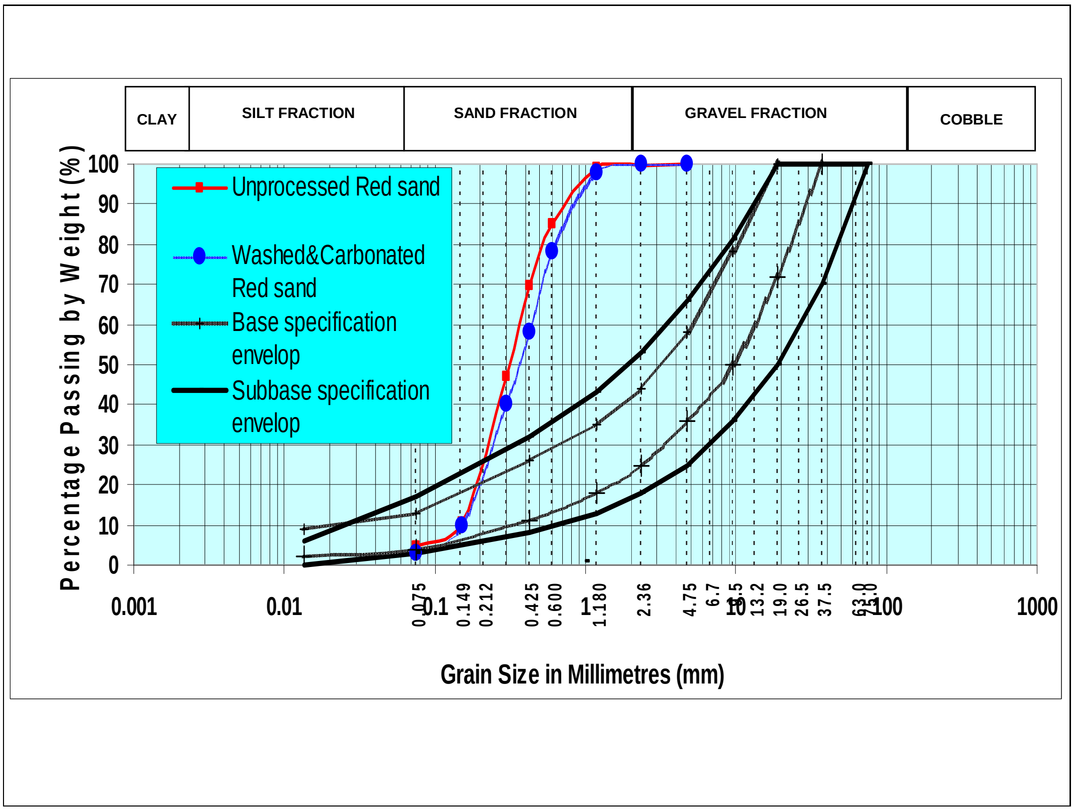

Figure 4.4 The red sand gradation charts and the particle size distribution boundary of subbase and base materials

4.2.2 Particle shape

To study the particle shape of red sand in this study, a modern optical microscope which has a digital camera was used. Figure 4.5 shows the image magnified fifty times of red sand comparing both sands with Perth sand. The particles shown in figure 4.5 illustrate the different features of particle appearance. Perth sand is well rounded and frosted, whereas red sand formed by crushing large mineral chunks has sharp edges and corners. The surfaces are not striated, frosted, or etched.

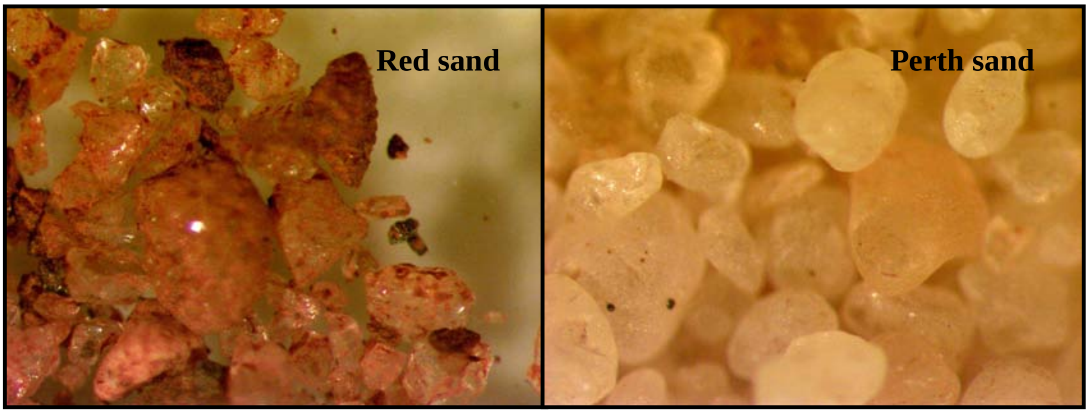

Figure 4.5 Optical microscopy comparison of red and Perth sand

4.2.3 Compaction

Figure 4.6 shows the compaction test results of both red sands in forms of the compaction charts of both the modified compaction test and the standard compaction test. For the modified compaction test on both red sands, the maximum dry densities (unit weight) are 1.83 tons/m^3 of unprocessed red sand and 1.80 tons/m^3 of washed and carbonated red sand. The modified optimum moisture contents are 17 % of unprocessed red sand and 18 % of washed and carbonated red sand. For the standard compaction test on red sands, the maximum dry densities (unit weight) are 1.59 tons/m^3 of unprocessed red sand and 1.61 tons/m^3 of washed and carbonated red sand. The standard optimum moisture contents are 21% of unprocessed red sand and 22% of washed and carbonated red sand.

These compaction test results on red sand also indicate that the effect of the compaction effort still exists on the compaction characteristics of red sand. More compaction effort (modified compaction) on red sands makes the maximum dry density increase decreasing their optimum moisture contents when compared to less compaction effort (standard compaction). Based on the compaction theory, if the compaction effort per unit volume of soils is changed, its compaction chart also changes. This can be seen in figure 4. 7, which performs four compactions curves of a sandy clay. The number of blows per a layer varying from 20 to 50 indicates the variation of the energy per unit volume. It can be seen that as the compaction effort is increased, the maximum dry density of compaction is also increased, but the optimum moisture content is decreased. This conforms to the compaction characteristics of red sand.

Moreover, it should be noted that from the previous items of the particle size distribution and particle shape of red sands, they perform like Perth sand. Conversely, the compaction characteristics of both red sands are quite different from cohesionless soils (sands). Normally, cohesionless soils do not respond to variation in compacting moisture content and compactive effort in the manner characteristic of fine-grained soils such as clay. Figure 4.8 shows the typical compaction curve for cohesionless soils. The low density that is obtained at low water contents is due to capillary forces resisting rearrangements of the sand grains. This phenomenon is known as bulking (Lamb & Whitman, 1979)

At this stage, it can be concluded that the particle size distributions of both red sands are similar to that of Perth sand, but the compaction characteristics of both are completely different from Perth sand.

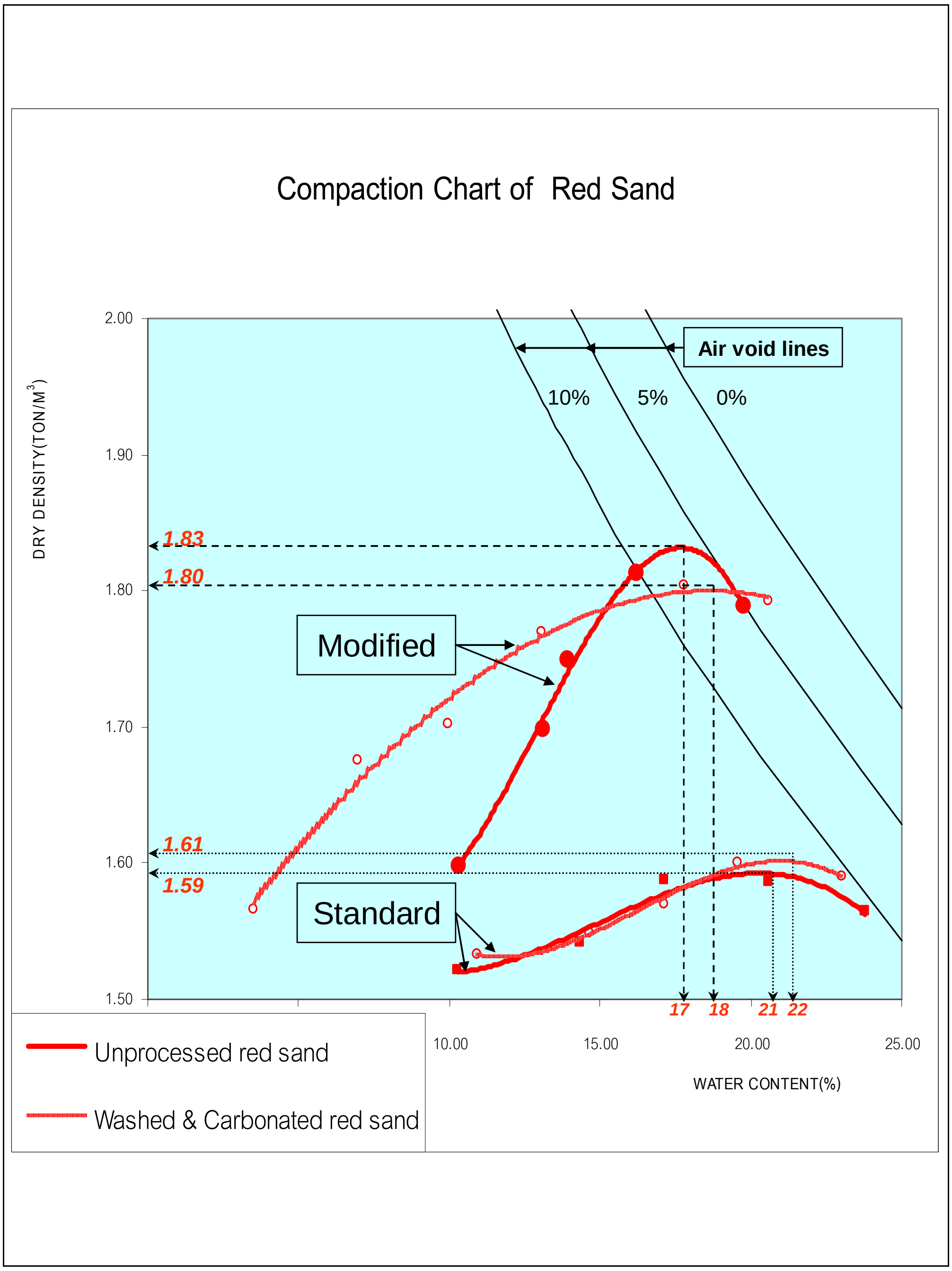

Figure 4.6 Compaction test results of both red sands

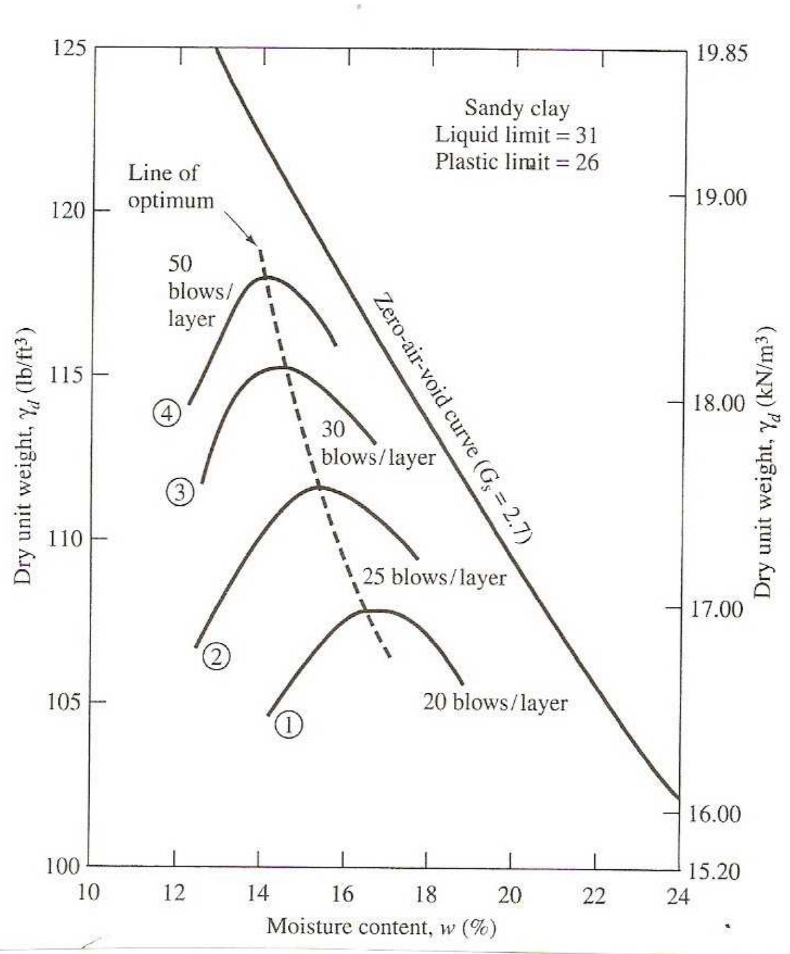

Figure 4.7 The effect of compaction energy on the compaction of a sandy clay (Das, 2002)

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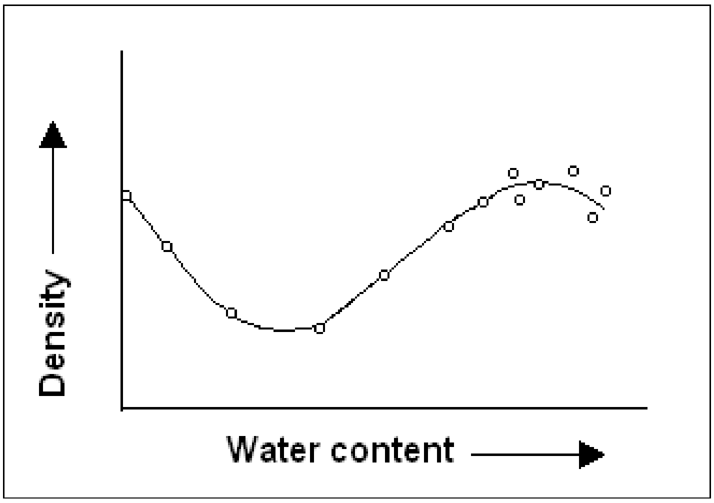


Figure 4.8 A typical compaction curve for cohesionless sand and sandy gravel (Lamb & Whitman, 1979)

4.2.4 Specific gravity

Table 4.1 shows the values of specific gravity of red sand comparing it with that of another type of red sand from a previous study (Hirsigner, 2005).

Table 4.1 The specific gravity of red sands

Red Sand	High Silica (Hirsigner, 2005)	Unprocessed			Washed and Carbonated	
No.of tests	1	1	2	3	1	2
Gs	2.50	3.02	3.04	3.02	3.09	3.07
Average	**2.50**	**3.03**			**3.08**	

It can be observed that the specific gravity of the unprocessed red sand and the washed and carbonated red sand which were used in this study are similar. Although the washed and carbonated red sand contains coarser particles, the mineral compositions of both types of red sand are the same; hence the specific gravity would be identical.

This can be illustrated further in the case of high silica red sand. Iron oxide (Fe_2O_3), which is usually the main mineral composition of red sand, was removed to produce high silica red sand. The iron oxide causes the red sand to be heavy; hence, its removal of iron oxide changes its mineral composition of red sand thus reducing its particle density.

Also it should be noted that iron oxide, Fe_2O_3 (molecular weight of 71.85) as a compound is heavier in molecular weight in comparison to Silicon oxide, SiO_2 (molecular weight of 60.08). Reducing the iron oxide would have a greater effect on the specific gravity than removing the same amount of silicon composition which account for a 0.5 variation in specific gravity between high silica red sand and unprocessed red sand.

When comparing the specific gravity of red sands with that of Perth sand (Gs=2.62), it was found that even if red sands are likely to be cohesionless soil obviously their specific gravity is much higher than a general cohesionless soil such as Perth sands.

4.2.5 Permeability

Table 4.2 shows the permeability test results of red sand, unprocessed red and washed and carbonated red sand, in terms of the coefficient of permeability, k which illustrates the different values based on the methods of compacting samples (modified compaction and standard compaction). Laboratory tests were conducted using two different kinds of apparatus shown in figure 4.9. The apparatus on the left did not leak water and compaction was performed by means of a tamping rod to achieve the target density of red sand. For the apparatus on the right, water could not be prevented from leaking from its joints due to the three piece setup (complete sealing of a joint using wax is not possible), but the amount of that was very less. It would be having a minimise effect on the results. However, due to larger apparatus diameter, compaction could be performed properly using a compaction test apparatus and hence a more uniform density was obtained.

Table 4.2 Permeability test results of red sand

Red sand	Coefficient of permeability, k (cm/s)	
	standard	modified
Unprocessed	6.93×10^{-4}	1.54×10^{-4}
Washed and carbonated	8.69×10^{-4}	3.0×10^{-4}

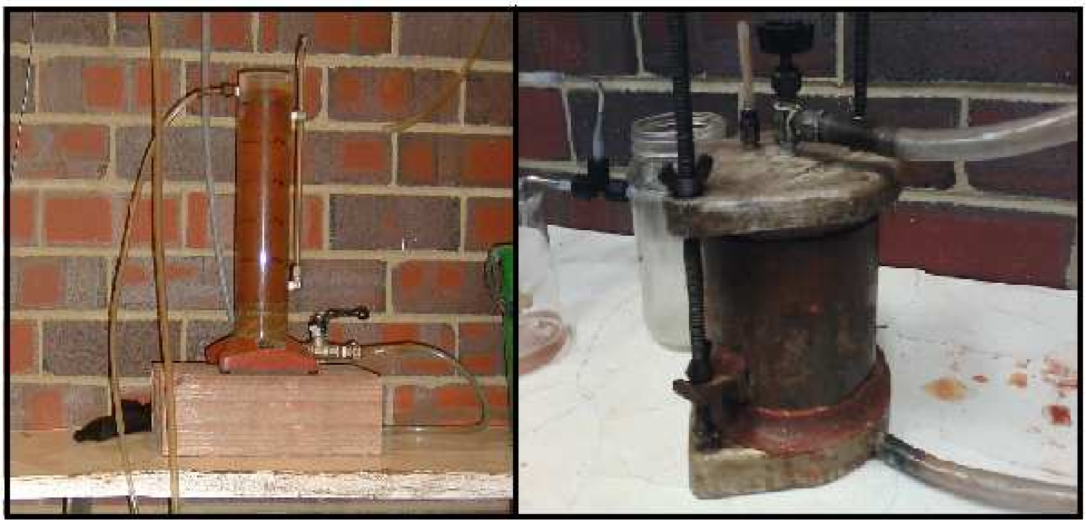


Figure 4.9 Washed and carbonated red sand (left) and unprocessed red sand (right) on the permeability mould setup

It is difficult to determine which of the two tests yields a better result. However, the results (8.69×10^{-4} to 1.54×10^{-4} cm/s) of both red sand types could be grouped as a low degree of permeability with coefficient of permeability between $10^{-3} – 10^{-5}$ cm/s according to the literature classification (Terzaghi & Peck, 1967) (see table 4.3).

Table 4.3 Classification of soils according to their coefficient of permeability (Terzaghi & Peck, 1967)

Degree of Permeability	Value of K (cm/sec)
High	Over 10^{-1}
Medium	$10^{-1} – 10^{-3}$
Low	$10^{-3} – 10^{-5}$
Very Low	$10^{-5} – 10^{-7}$
Practically impermeable	Less than 10^{-7}

The permeability of a material is inversely proportional to its density. Dense soils normally have a lower permeability coefficient due to the densely packed material preventing water from seeping between the particles.

The lower permeability of unprocessed red sand than washed and carbonate red sand is probably due to its ability to be compacted into a denser structure. The unprocessed red sand as discussed previously has a higher maximum dry density in comparison to the washed and carbonated red sand in particular a high compactive effort.

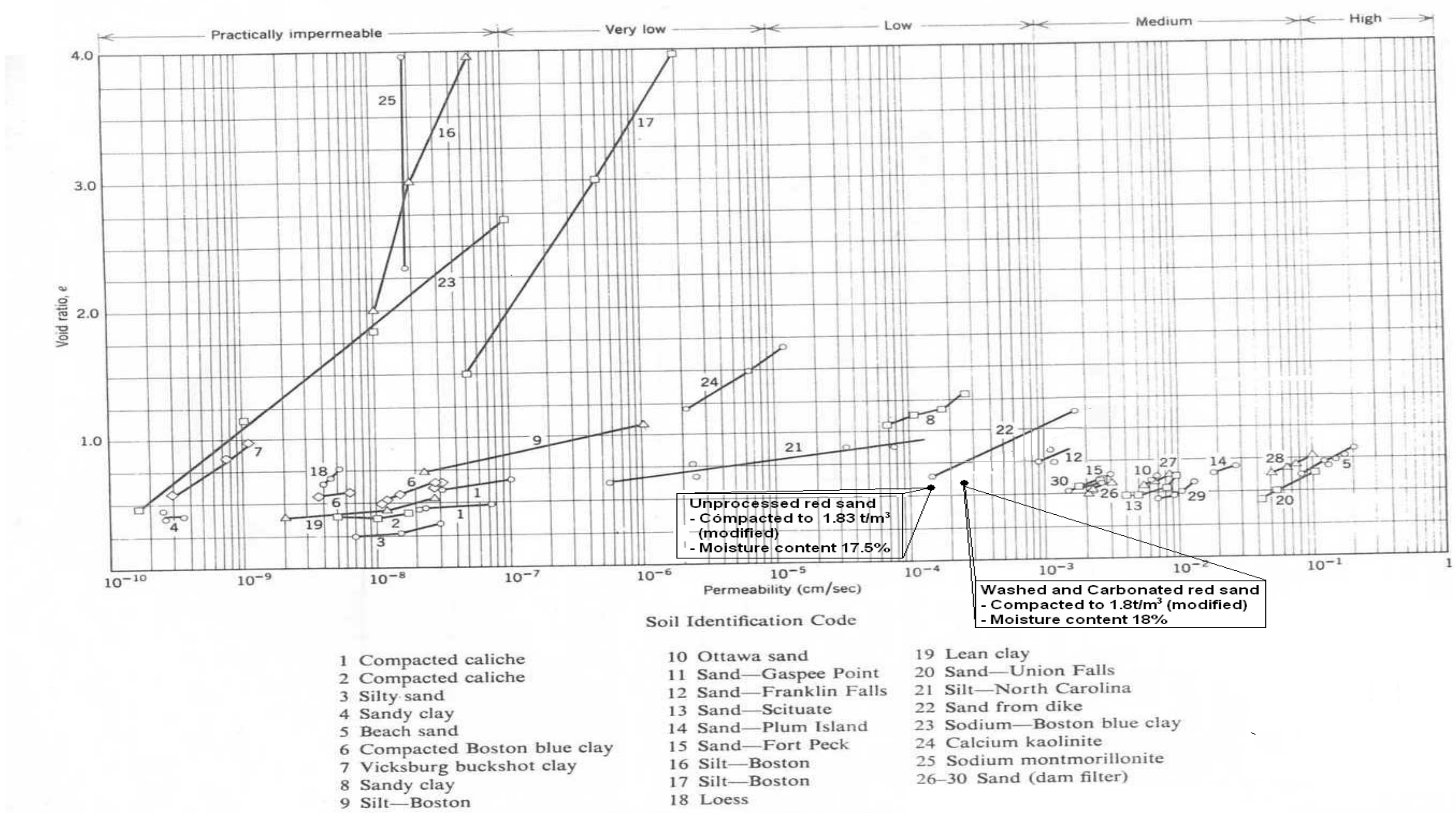
However, the permeability characteristic of soils usually relates to the void ratio, e. In practise, the void ratio is very hard to measure but it can be determined from the phase diagram relationship of soils. The formula which relates to dry density, specific gravity, and unit weight of water can be established. Table 4.4 shows the void ratio of compacted red sand following the compaction methods.

Figure 4.10 shows the coefficient of permeability of compacted red sand related to its void ratios comparing it with various soil types.

Table 4.4 Void ratio and permeability relationship

Red sand	Compaction	γ_d (t/m^3)	γ_w (t/m^3)	G	*e*
Unprocessed Red Sand	Modified	1.83	0.998	3.03	0.65
Washed and Carbonated red Sand	Modified	1.80	0.998	3.08	0.71

Figure 4.10 Permeability of red sand, with adaptation (Lamb & Whitman, 1979)



4.2.6 California Bearing Ratio (CBR)

Table 4.5 shows the results of the California Bearing Ratio (CBR) from this study and the specifications of Austroad (Austroads, 2004).

Table 4.5 California Bearing Ratio (CBR) results and specifications

California Bearing Ratio (CBR) results (%)		
Test methods	Soaked	Un-soaked
Unprocessed red sand	55	33
Washed and carbonated red sand	56	50
Unprocessed red sand 65% fly ash 30% lime 5% (Hirsigner, 2005)	170	N/A
CBR values (%) for Austroads minimum specification (Austroads, 2004)		
Recycled concrete subbase	50	N/A
Recycled concrete base course	100	N/A
Gravel base course	80	N/A
Ferricate base course	80	N/A
Crushed rock base course	100	N/A

It should be noted that based on CBR results and specifications, both red sand types cannot comply with the specifications of road base materials. However, the stabilisation of red sand would probably be an alternative way to use red sand as a road base material. From figure 4.11, it can clearly be seen that when red sand is stabilised by mixing it with some amounts of fly ash and lime kiln dust, it gives a higher a CBR value than by itself.

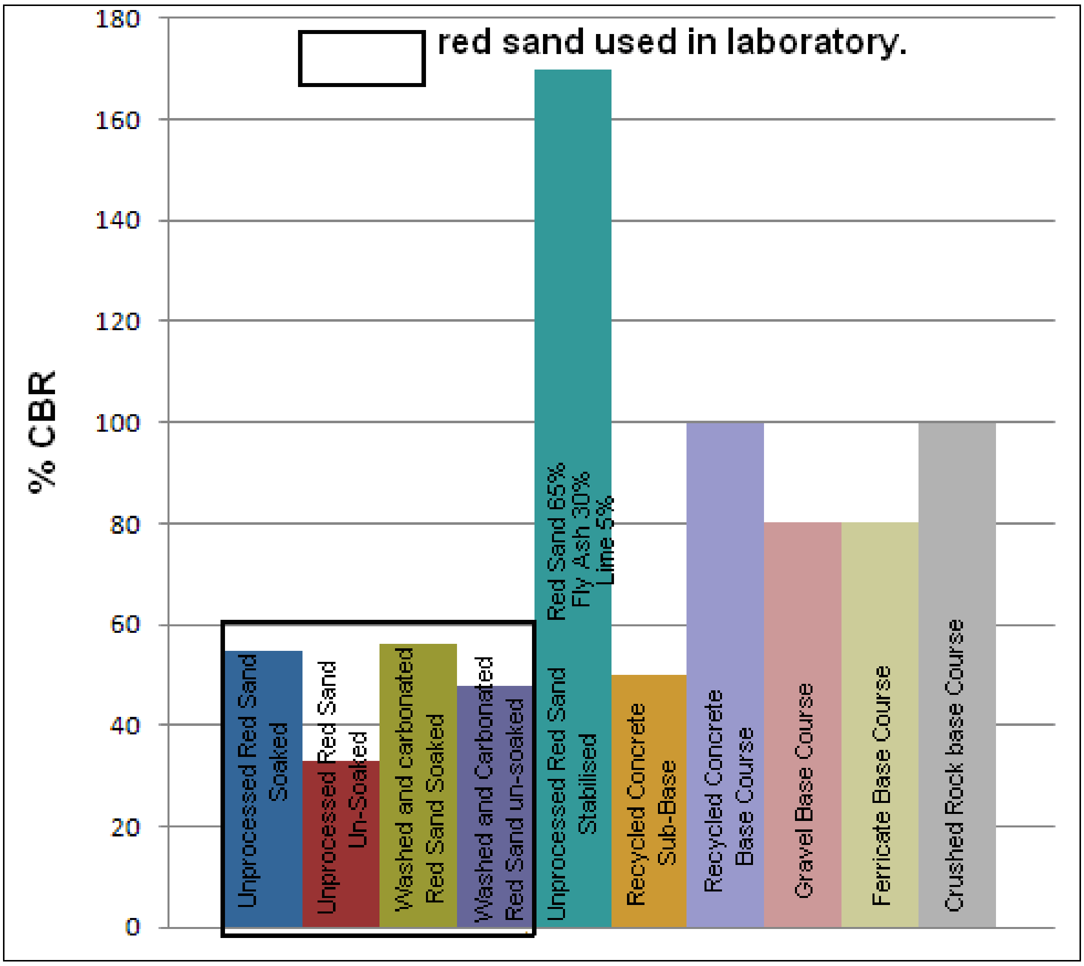


Figure 4.11 Comparison of CBR values

4.2.7 Strength

This section presents the results and discussion of direct shear tests operated on both types of red sands which were compacted at 95% maximum dry density and 100% optimum moisture content derived from the compaction curve. The purpose of the tests was to examine the strength characteristic and to determine the shear strength parameters of red sands under the direct shear test. It should be noted that all direct shear tests conducted in this section were carried out using the dry method (not allowing the tested sample to be soaked in the water). This means the strength parameters from this test are the total stress parameters.

Tables 4.6 and 4.7 illustrate the test results from the direct shear tests. Moreover, figures 4.12 and 4.13 exhibit a series of graphs of the stress strain relationship from these tests. Figures 4.14 and 4.15 are the relative graphs of the peak and ultimate stresses plotted against normal stresses and then a straight line was fitted through the data to form a Mohr-Coulomb failure envelope to obtain shear strength parameter, ϕ (i.e. peak friction angle and ultimate friction angle).

Table 4.6 Ultimate stresses and peak stresses results of direct shear tests

Normal Stress kPa	Unprocessed Red Sand)				Washed and Carbonated Red Sand			
	Standard		Modified		Standard		Modified	
	Ultimate Stress, kPa	Peak Stress, kPa	Ultimate Stress, kPa	Peak Stress, kPa	Ultimate Stress, kPa	Peak Stress, kPa	Ultimate Stress, kPa	Peak Stress, kPa
97.3	77	90	82	106	92	105	107	130
177.3	130	162	152	174	158	188	174	192
257.3	200	217	213	249	209	227	225	260

Table 4.7 Shear strength parameters (ϕ) for red sands using the results of direct shear tests

Unprocessed Red Sand				Washed and Carbonated Red Sand			
Standard		Modified		Standard		Modified	
Ultimate Friction angle, ϕ(degree)	Peak Friction angle, ϕ(degree)	Ultimate Friction angle, ϕ(degree)	Peak Friction angle, ϕ(degree)	Ultimate Friction angle, ϕ (degree)	Peak Friction angle, ϕ(degree)	Ultimate Friction angle, ϕ (degree)	Peak Friction angle, ϕ(degree)
37.48	40.56	40.03	45.00	40.30	43.6	42.8	46.7

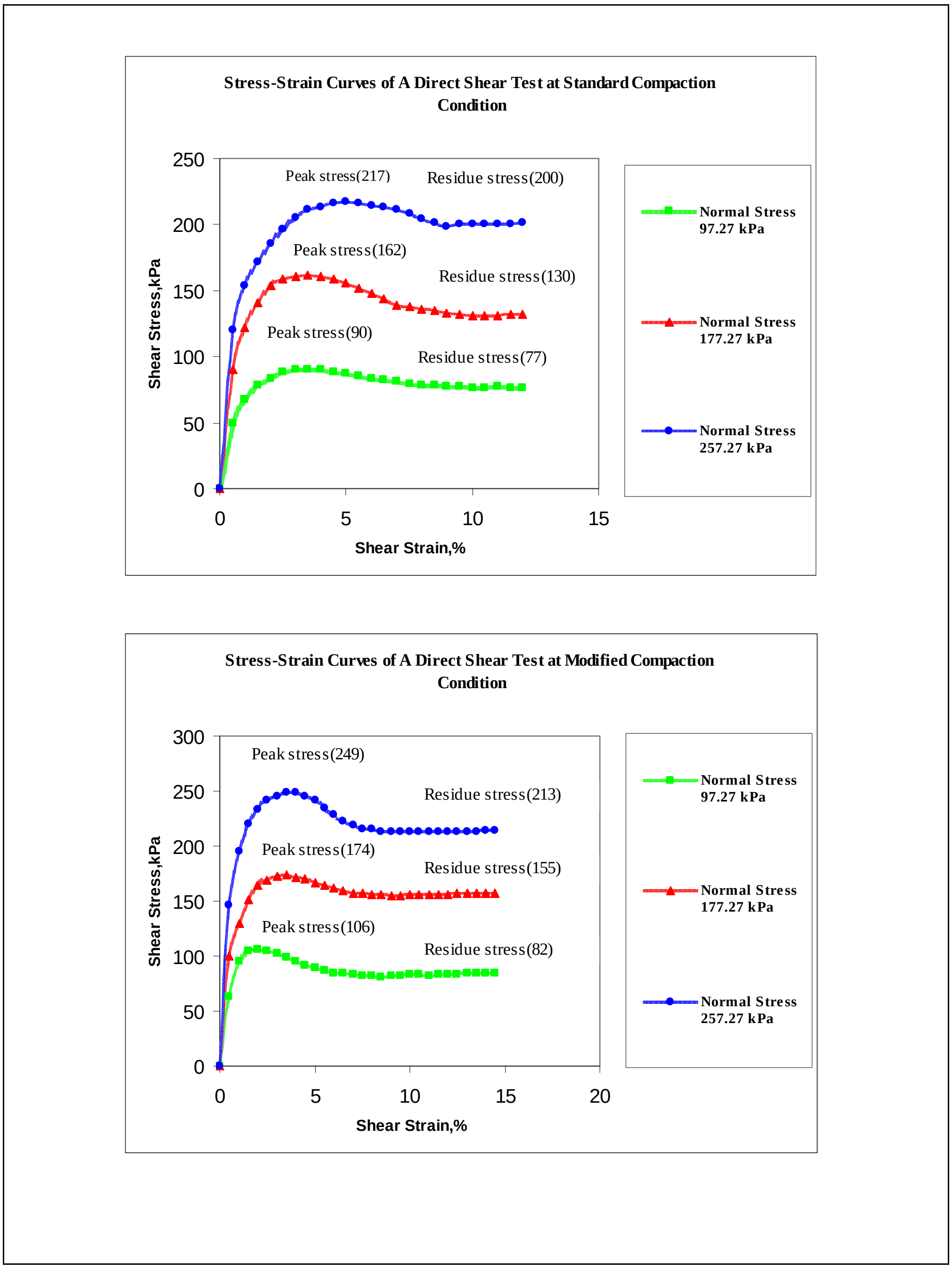


Figure 4.12 Stress-strain relations of unprocessed red sand from the direct shear tests

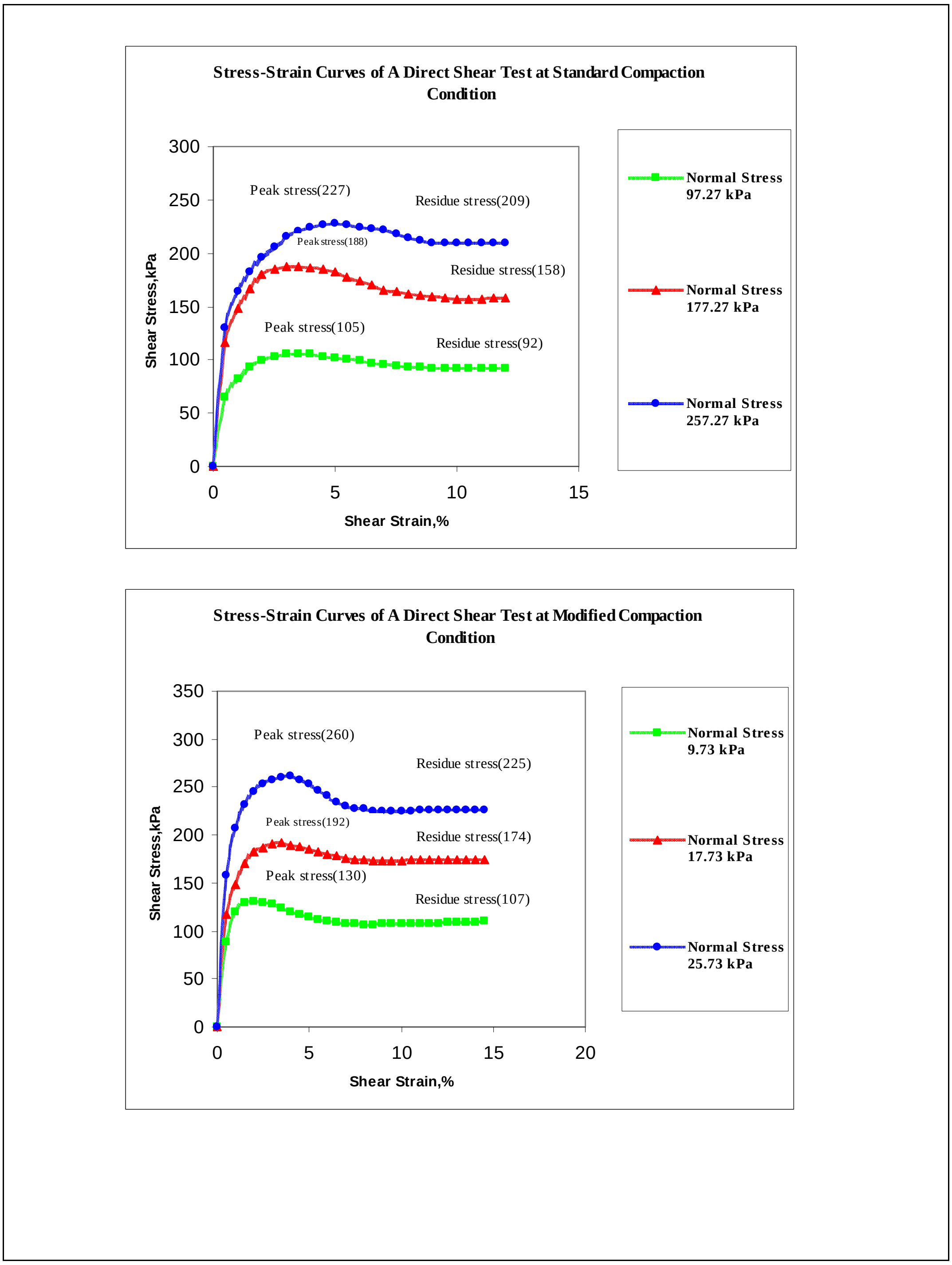


Figure 4.13 Stress-strain relations of washed and carbonated red sand from the direct shear tests

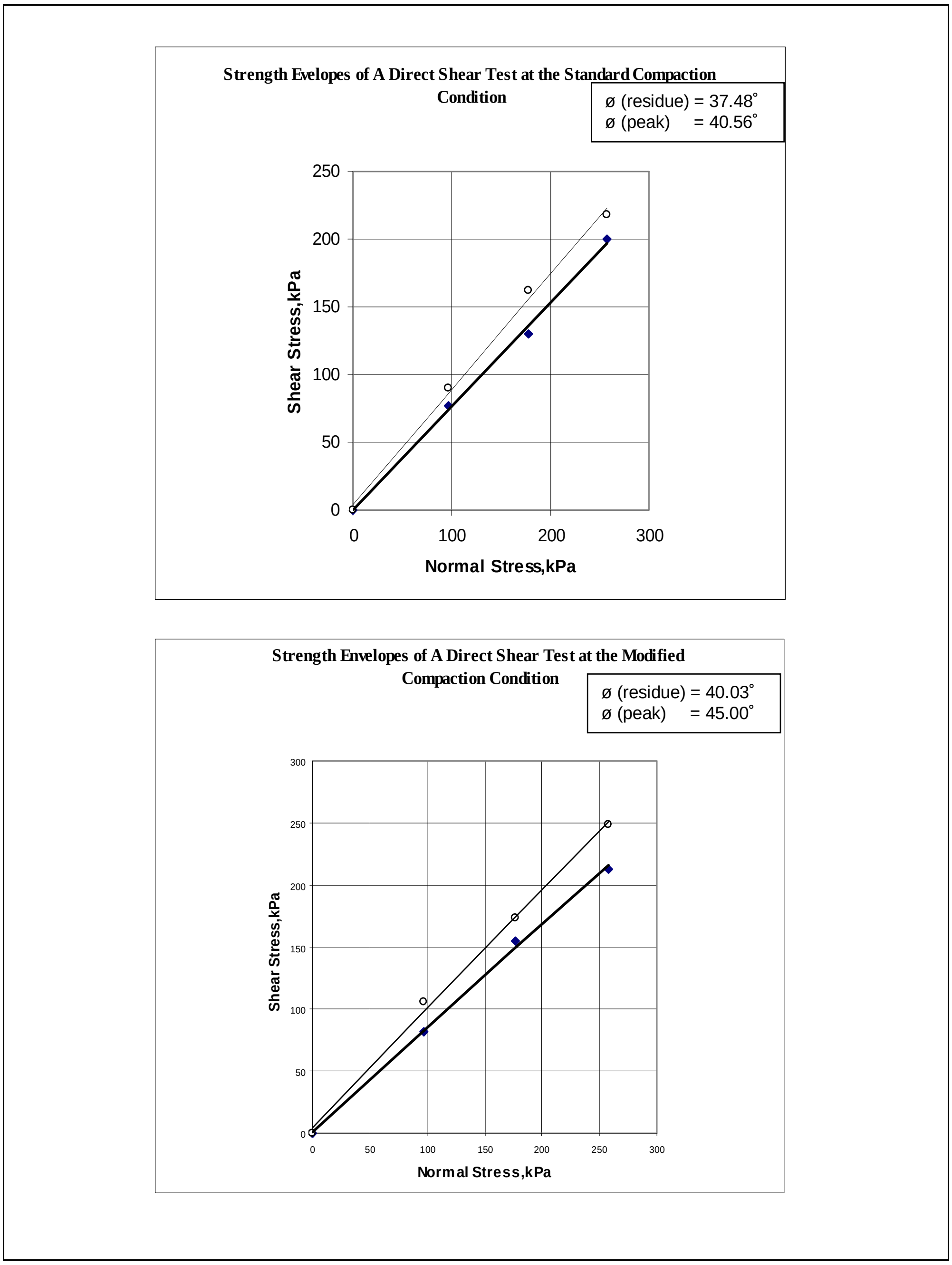
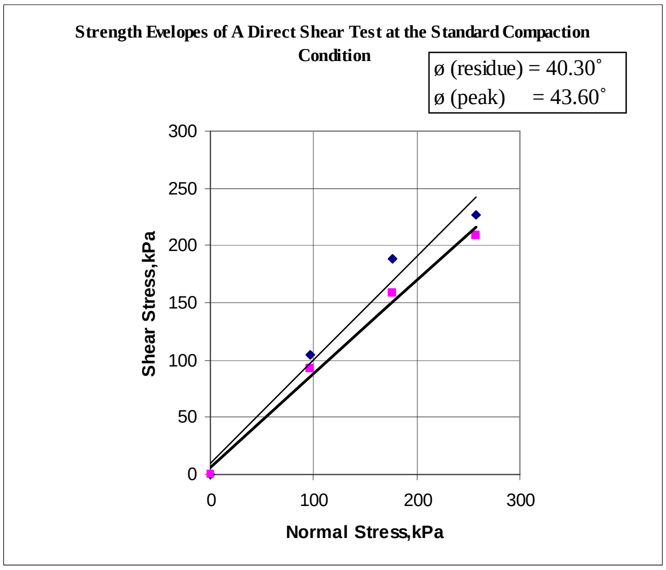


Figure 4.14 Mohr-Coulomb failure envelopes and friction angles of unprocessed red sand from the direct shear tests



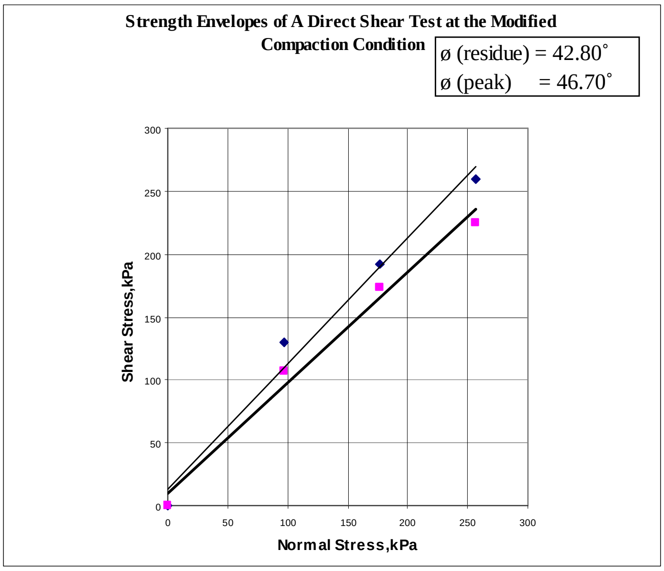


Figure 4.15 Mohr-Coulomb failure envelopes and friction angles of washed and carbonated red sand from the direct shear tests

Following these test results, washed and carbonated red sand attains higher friction angles of both ultimate and peak friction angles than unprocessed red sand. However, both types of red sand shows the very good strength parameter (friction angles more that 40 degrees). Table 4.8 shows some friction angles of soils for preliminary slope designs. Both red sands can give the friction angles as good as the dense sand and gravel which is in the range of 40 to 48 degrees.

Table 4.8 Summary of friction angle data for use in preliminary design (Lamb & Whitman, 1979)

	Slope Angle of Repose		At Ultimate Strength		At Peak Strength			
					Medium Dense		Dense	
Classification	$i(^\circ)$	Slope (vert. to hor.)	$\phi_{cv}(^\circ)$	$\tan\phi_{cv}$	$\phi(^\circ)$	$\tan\phi$	$\phi(^\circ)$	$\tan\phi$
Silt (nonplastic)	26 to 30	1 on 2 1 on 1.75	26 to 30	0.488 0.577	28 to 32	0.532 0.625	30 to 34	0.577 0.675
Uniform fine to medium sand	26 to 30	1 on 2 1 on 1.75	26 to 30	0.488 0.577	30 to 34	0.577 0.675	32 to 36	0.675 0.726
Well-graded sand	30 to 34	1 on 1.75 1 on 1.50	30 to 34	0.577 0.675	34 to 40	0.675 0.839	38 to 46	0.839 1.030
Sand and gravel	32 to 36	1 on 1.60 1 on 1.40	32 to 36	0.625 0.726	36 to 42	0.726 0.900	40 to 48	0.900 1.110

From B. K. Hough, *Basic Soils Engineering*. Copyright © 1957, The Ronald Press Company, New York.
Note. Within each range, assign lower values if particles are well rounded or if there is significant soft shale or mica content, higher values for hard, angular particles. Use lower values for high normal pressures than for moderate normal

4.3 Part 2: Red sand for road bases

4.3.1 Outline

For the part 2, red sand for road bases, the experimental results of the red sand stabilisation and the stabilised red sand verification are presented. First, a series of results of compaction tests and unconfined compressive strength tests for determining the best mixtures (unprocessed red sand, fly ash, and lime kiln dust) are shown and then the best mixture is presented. After that, a battery of results of resilient modulus tests, permanent deformation tests, and static drained triaxial tests on the appropriate stabilised red sand and the reference material (HCTCRB) are explained. Additionally, the models of resilient modulus and permanent deformation of both materials are established and presented. A comparison of the results on the verification stage is made at the end of this section.

4.3.2 Red sand stabilisation

The first stage of red sand stabilisation is the determination of the optimum proportions of red sand and fly ash mixture, based on compaction test results. Optimum proportions of mixtures were tested of the red sand and fly ash.

Figure 4.16 shows the compacted dry density versus water content curves of the red sand and fly ash mixtures. The results show that compacting red sand and fly ash produces a higher maximum dry density when compared with only red sand or fly ash by itself. As the fly ash content (FA) increased from 10 to 30%, the maximum dry density increased. Increasing fly ash content from 10 to 20% increased the maximum dry density dramatically. Conversely, increases in the fly ash content from 30 to 50% caused decreases in the maximum dry density. Studies of silty sands, which are the soil type of the mixture of red sand and fly ash, reveal that, with a low amount of non-plastic silt content, in the range of 0 to 25%, both the maximum dry density and the minimum dry density increase with increasing fine content because the fines occupy the void between sand particles. However, if the fines content exceed 25%, there is a decrease in the maximum dry density and the minimum dry density of this silty soil (Kuerbis et al., 1988). In the case of red sand and fly ash mixtures, the larger quantity of fly ash content (i.e., FA more than 30%) caused the red sand particles not to be fully in contact. At the fines content of 40% and 50%, the red sand particles tended to be separated, floating in a fly ash matrix.

The main objective of this stage was to find the proportion of red sand and fly ash mixture which would give the maximum dry density. Figure 4.16 shows that 70% red sand and 30% fly ash by dry weight gave the highest maximum dry density in a series of these tests of 1.99 ton/m^3. This proportion had the optimum water content of 9.2%.

Once the optimum mixture was determined, the determination of an appropriate amount of the activator was established. In this stage, the specimens of red sand, fly ash, and lime kiln dust, the activator, were tested by means of unconfined compressive strength (UCS) tests. Figure 4.17 illustrates these results of UCS tests.

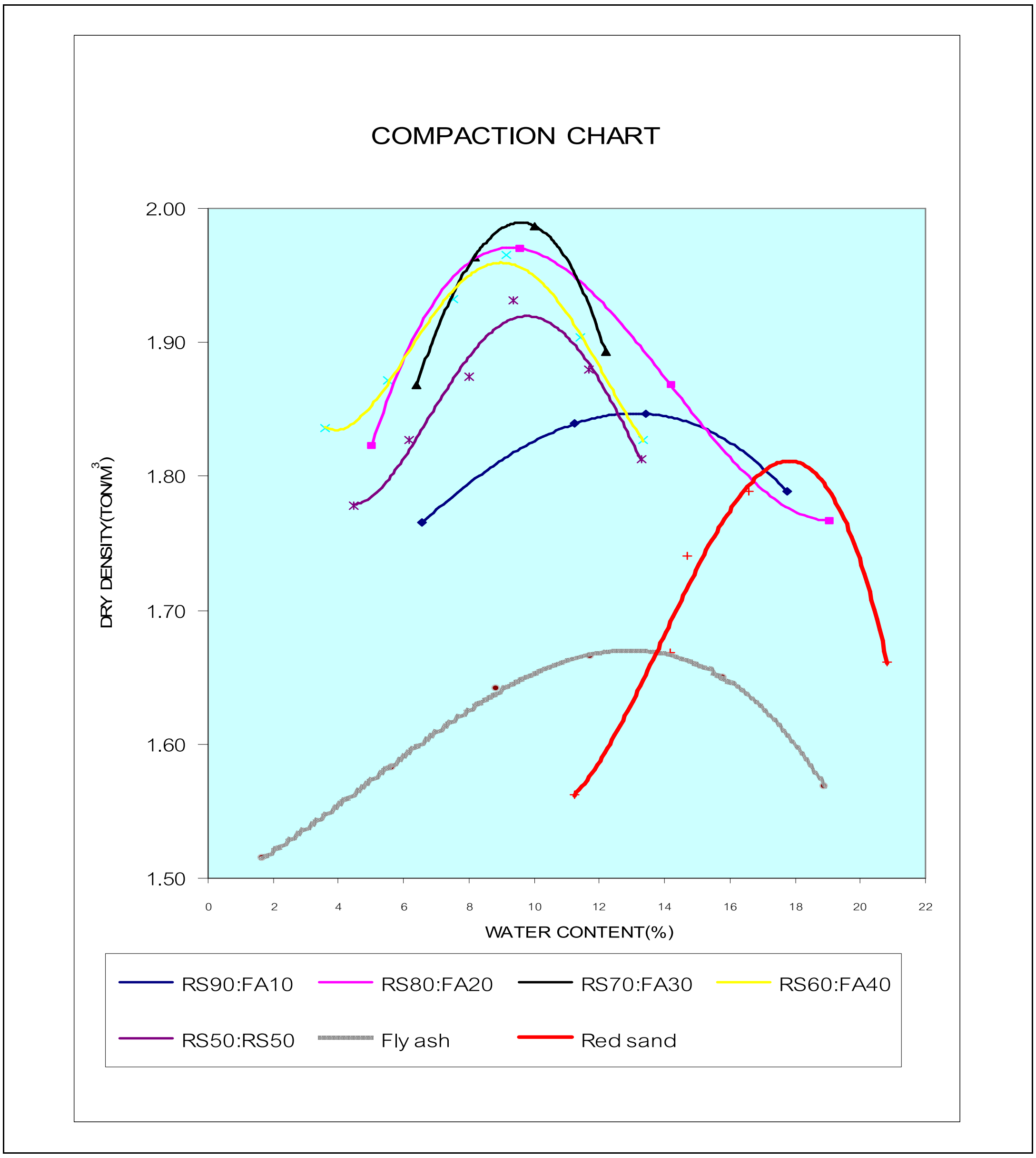


Figure 4.16 The compaction curves of determination of the optimum proportion of the red sand and fly ash mixtures.

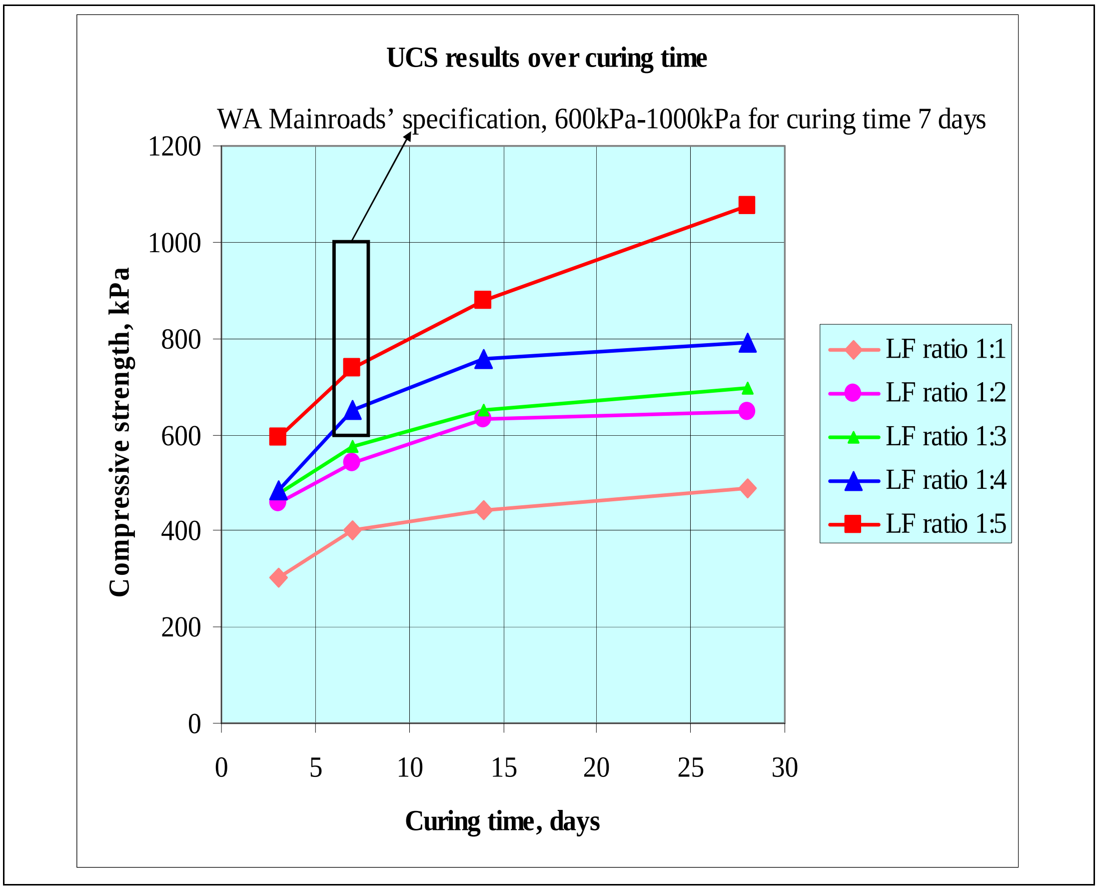


Figure 4.17 Unconfined compressive strength test results

Figure 4.17 shows the effect of curing time on unconfined compressive strength. All the specimens increased with curing time. Varying quantities of lime kiln dust (i.e. LF ratio 1:1 to LF ratio 1:5) were added to the base mixtures, red sand and fly ash, to investigate the effect of lime kiln dust content on the unconfined compressive strength. As could be seen in Figure 4.17, the unconfined compressive strength of the specimens clearly shows that the specimen having the least amount of lime kiln dust content give the higher unconfined compressive strength. A curing time 7 days, the least lime kiln dust content specimen (LF ratio 1:5) had the highest unconfined compressive strength. However, the objective of the unconfined compressive strength test was to find out what LF ratio had an unconfined compressive strength equal to or better than the specification. As shown in figure 4.17, the LF ratios for the specimen with a ratio of 1:5 and 1:4 were in the range of WA Mainroads' specification, between 600 kPa and 1000 kPa.

Based on the results of the compaction tests and the unconfined compressive strength tests, the expected proportions of red sand, fly ash, and lime kiln dust are 70% of red sand: 25% of fly ash: 5% of lime kiln dust (LF ratio 1:5) and 70% of red sand: 24% of fly ash: 6% of lime kiln dust (LF ratio 1:4) for the percentage by dry weight of the mixtures.

4.3.3 Verification of red sand stabilisation

The characteristics of resilient modulus, permanent deformation, and shear strength were used in this verification stage because they are significant to road performance.

Successful pavement layers must exhibit high resilient modulus in order to spread load adequately and to reduce resilient deformation of upper bituminous layers. The pavement must resist internal, permanent deformation which might contribute to surface rutting . The resilient modulus or stiffness of pavement structures is also a critical factor in determining the thickness and composition of pavement layers. It performs more reliably the pavement behaviour under the repeated loading condition which simulates the real condition of traffic loading in laboratory testing, as well. The permanent deformation of pavement materials is manifested as rutting and shoving, the visible damage on the road coming from the excess deformation of the pavement, results from the pavement material having insufficient stability to cope with the prevailing loading and environmental conditions. Consequently, both resilient modulus and permanent deformation characteristics would be parameters to examine the suitability of stabilised red sand as road base materials.

Shear strength characteristics of a base course material are also significant as they can provide valuable in formation on the material quality in resisting external loads. The failure envelope of such material is relevant to evaluate maximum capacity for withstanding the applied loads. This envelope is based on the shear strength parameters (c and ϕ). In this study, shear strength parameters of stabilised red sand and the reference material (HCTCRB) are determined by means of the static drained triaxial tests.

In Western Australia, crushed rock added with 2% General Purpose (GP) cement or HCTCRB is suitable for Western Australia roads. Accordingly, this conventional material was used to be the control material in this study. If the stabilised red sand is equal to or better than such material in terms of resilient modulus, permanent deformation, and shear strength characteristics, it can be concluded that the stabilised red sand is good enough for use as the road base material in Western Australia. In this verification stage, the stabilised red sand specimen of the proportion of 70% red sand, 25% fly ash, and 5% lime kiln dust (LF ratio 1:5) was selected to be the representative stabilised red sand for resilient modulus, permanent deformation, and shear strength tests.

Stabilised red sand

- *Static triaxial tests*

Static triaxial tests by means of the drained triaxial compression tests were perform to obtain information on the cohesion (c) and the internal friction angle (ϕ) of the representative stabilised red sand. These tests also established the failure line of such stabilised red sand to determine the maximum stress level which could be applied on this material, so that the limited uses of the stabilised red sand would be known. The confining pressures of 50 kPa, 100 kPa, and 150 kPa were applied on the tested specimens in each test. The stabilised red sand specimens were prepared following the details suggested in section 3.3.2.

Figure 4.18 depicts the relationship of the deviator stress and the axial strain at the three selected confining pressures. It also can be observed that the static deviator stress initially increases with increasing the axial strain until it reaches the peak strength. For a higher confining pressure, apparently, the peak strength becomes higher and strain corresponding to the peak strength becomes higher, as well. All three curves in Figure 4.18 exhibit that after the peak strength taken place, the postpeak regime, during which the stress reduces with increasing strain. This characteristic is similar to that of dense granular materials and is normally described as strain softening. The strain-softening process is concomitant with the generation of large deformations, which caused geometrically non-linear effects to become important(Suiker, Selig, & Frenkel, 2005). It should be note that for cemented stabilised materials (i.e. cement stabilisation), their stress-strain relationships usually perform as brittle materials that the stress-strain curve drop down dramatically after reaching the peak stress but the stabilised red sand shows the strain softening characteristic which would be a good characteristic for a road base material.

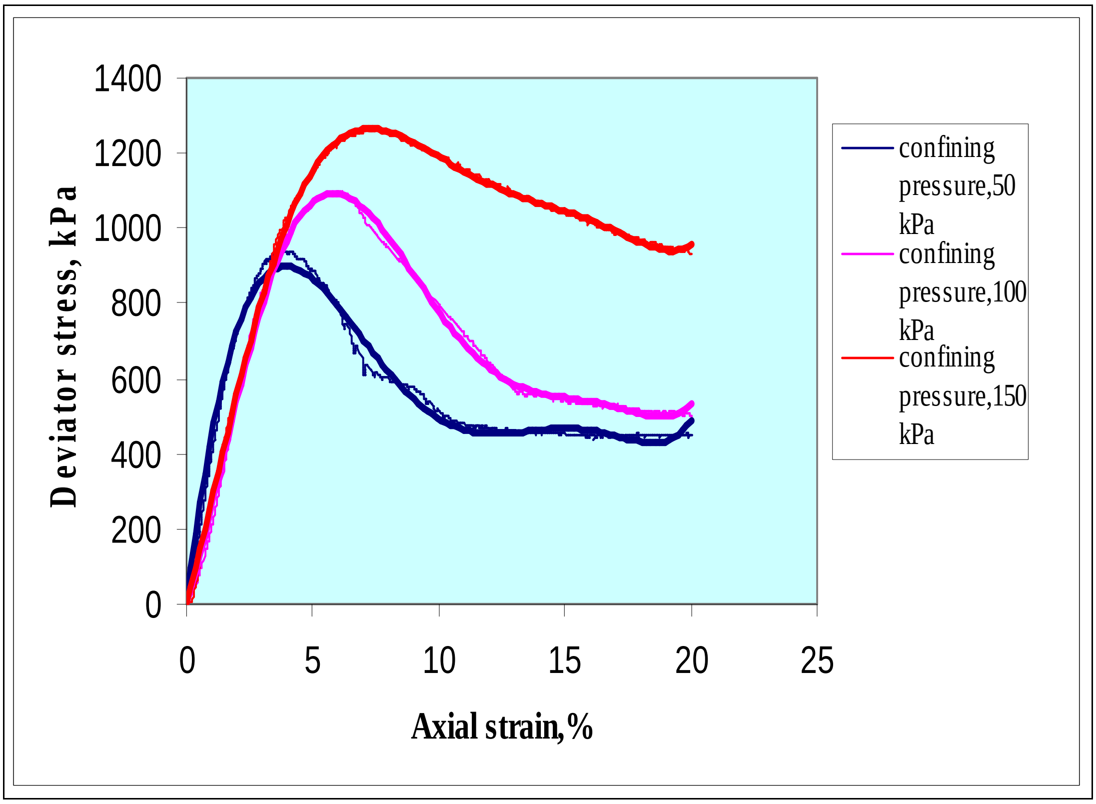


Figure 4.18 Stress-strain curves of stabilised red sand from static triaxial tests

The peak strength of stabilised red sand in these tests was interpreted using a Mohr-Coulomb failure law in which the cohesion (c) and the internal friction angle (ϕ) are considered in a failure relationship, a straight line fitted to a Mohr envelope (Lamb & Whitman, 1979). The peak deviator stresses from these stress-strain relations can be seen in table 4.9.

Table 4.9 The peak deviator stresses and confining pressures from static triaxial tests

Test no.	Confining pressure, ($\sigma 3$) kPa	Deviator stress, (σd) kPa
1	50	900
2	100	1080
3	150	1280

Figure 4.19 shows Mohr's circles and Mohr-Coulomb failure envelope of these tests. The results shown in Figure 4.19 indicate that the Mohr-Coulomb failure envelope (corresponding to the peak stresses) is linear for the stress range tested and in the conventional Mohr-Coulomb stress space, thus the properties failure correspond to an internal friction angle (ϕ) at peak strength of 41° and apparent cohesion (c) of 161 kPa.

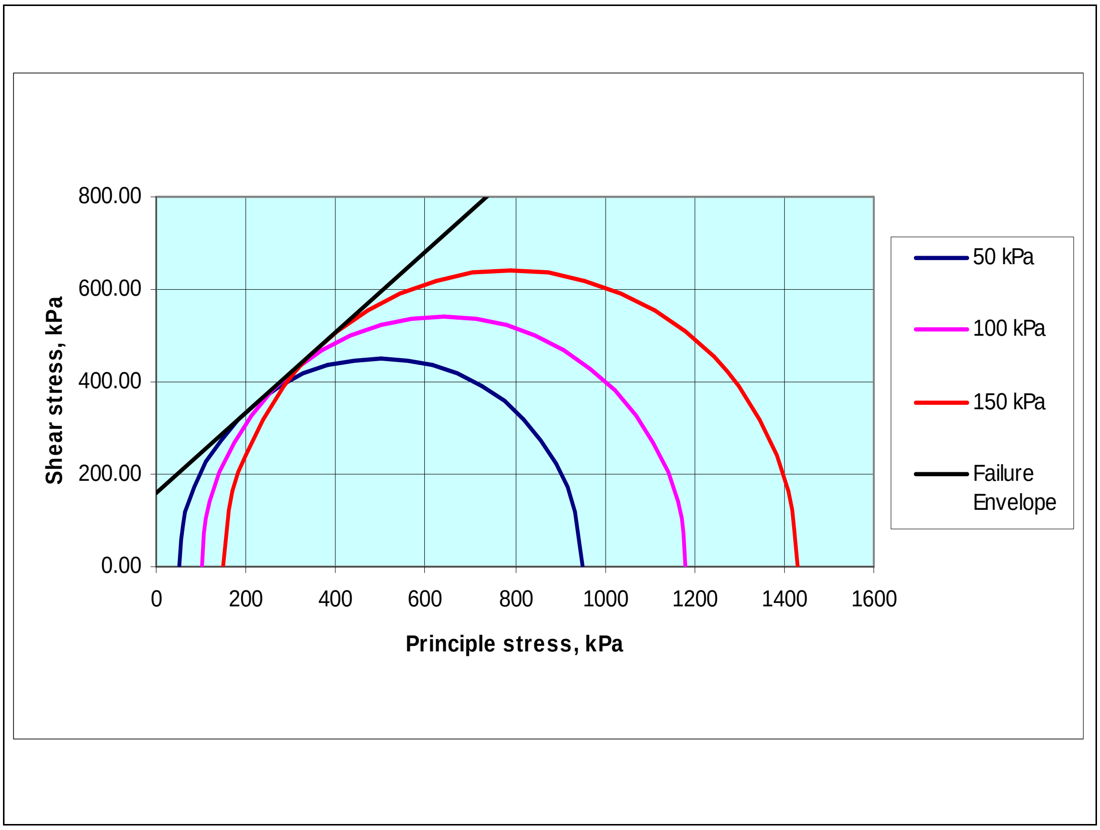


Figure 4.19 Mohr's circles and Mohr-Coulomb failure envelope from static triaxial tests in this study

- *Resilient modulus tests*

Resilient modulus is an important material property of base course materials and is an input parameter in pavement design. It is based on the recoverable strains taking place from a series of combinations of confining and dynamic deviator stresses in triaxial tests applied to soil specimens in order to take into the account non-linear behaviour of base course materials under traffic loading. Because the resilient modulus is the elastic properties of pavement materials, it could consider from the material behaviour under the elastic loading regime. Following the standard test method of Austroad-APRG 00/33(Voung and Brimble 2000), it allows a suite of 65 stress conditions having various stress levels applied to a tested specimen to characterise the vertical resilient (recoverable) strain under a combination of applied dynamic vertical and static confining stresses. Figure 4.20 exhibits the resilient modulus results of stabilised red sand with applied loading sequences.

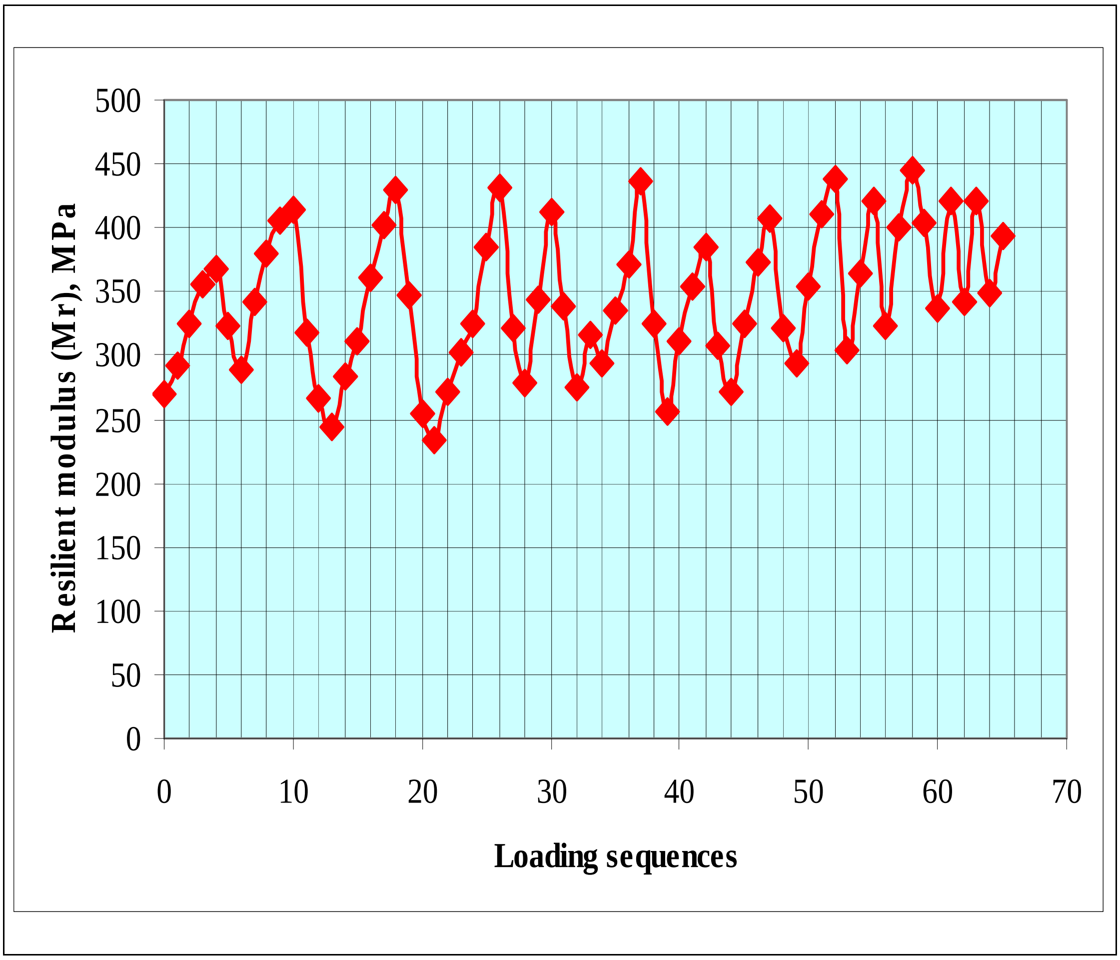


Figure 4.20 Resilient modulus results of stabilised red sand

The laboratory test for determining resilient modulus is expensive and time-consuming, meriting suitable numbers and quality specimens to be prepared and tested for reliable results. The resilient tests are conducted mostly the research and in review of perspective the complexity of the test and costly equipment requirements; it is desirable to find out a suitable resilient modulus model for the estimation of resilient modulus values. Furthermore, in recent years, the computer programs are relevant to pavement analysis and design so a suitable resilient modulus model is an important input parameter for the program.

Generally, the resilient modulus is non-linear with respect to the magnitude of applied stresses. The K-Theta (K-θ) model (Hick & Monosmith, 1971) and The Uzan model (Uzan, 1985) are the significant models for non-linear behaviour of the granular materials and they are taken into account for the resilient modulus behaviour of stabilised red sand in this study. Table 4.10 and Figure 4.21 show the results of modelling resilient modulus values of stabilised red sand based on the resilient modulus test in this study.

From figure 4.21, it can be seen that both models which were used in this study are very powerful resilient modulus models for stabilised red sand.

Table 4.10 Resilient modulus models for stabilised red sand

Model	Equation	The regression coefficients			Symbols
		K_1	K_2	K_3	
K-Theta (K- θ)	$M_r = k_1 \theta^{k_2}$ (Hick and Monismith, 1971)	33.427	0.381	-	M_r = Resilient modulus,MPa θ = Bulk Stress = $(\sigma_1+\sigma_2+\sigma_3)$ k_1, k_2= Regression coefficients
Uzan	$M_r = k_1 p_a \left(\frac{\theta}{p_a}\right)^{k_2} \left(\frac{\sigma_d}{p_a}\right)^{k_3}$ (Uzan, 1985)	2.380	0.001	0.336	M_r = Resilient modulus,MPa θ = Bulk Stress = $(\sigma_1+\sigma_2+\sigma_3)$ k_1,k_2,k_3= Regression coefficients p_a = Atmospheric pressure = 100 kPa σ_d = σ_1-σ_3

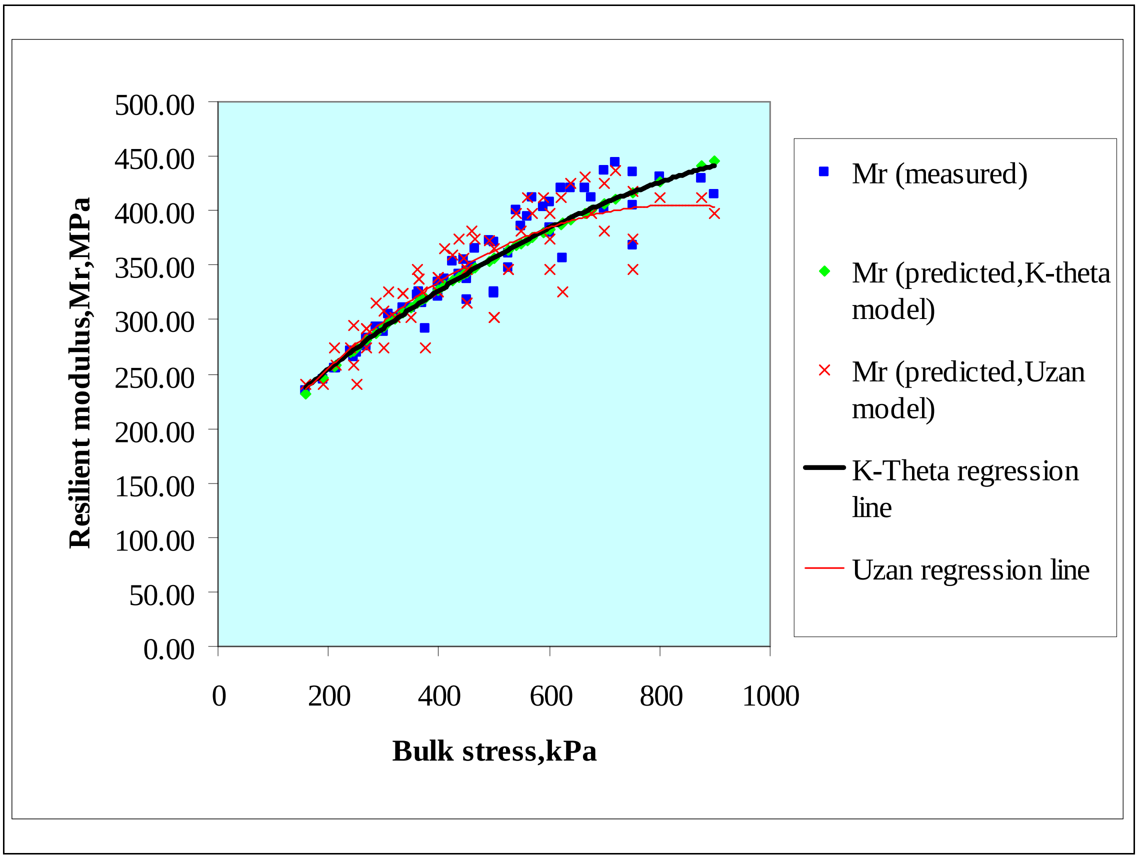


Figure 4.21 Comparison of resilient modulus values from the models and the measurement

- *Permanent deformation tests*

Permanent deformation of pavement materials, manifest as rutting and shoving, particularly along the outer wheel path near the pavement shoulder, results from the material having insufficient stability to cope with the prevailing loading and environmental conditions (Austroads, 2004). It is necessary to understand the pavement performance in terms of the permanent deformation characteristic under the traffic loading. Normally, the permanent deformation at the top of the base course is not taken as a design criterion unlike the tensile strain at the bottom of the asphalt layer and the vertical compressive strain or the permanent deformation at the top of the subgrade. However, stabilised red sand has been developed as an alternative material for road bases in Western Australia. Accordingly, its important characteristics which would effect to a road construction and design would be investigated for it significant and becomes meaningful for a new era of pavement engineering.

At the moment, there is no suitable model which reliably describes rutting development in the base course under traffic. However, to estimate rutting characteristics of stabilised red sand, the test procedure of the Austroad- APRG 00/33 standard (Voung & Brimble, 2000) was used in this study.

Figure 4.22 shows the typical results of the permanent deformation test in terms of the relationship between permanent deformation and loading cycles for stabilised red sand. The various test values can be extracted from Figure 4.22 for assessing the potential for permanent deformation under the real conditions. Furthermore, it can be noted that the permanent deformation of stabilised red sand is not dominant by the applied load in the testing range because when they increase from loading stage 1 to loading stage 3, the permanent deformation of such material does not increase dramatically. In contrast, the number of loading cycles seems to be more influent to the permanent deformation values.

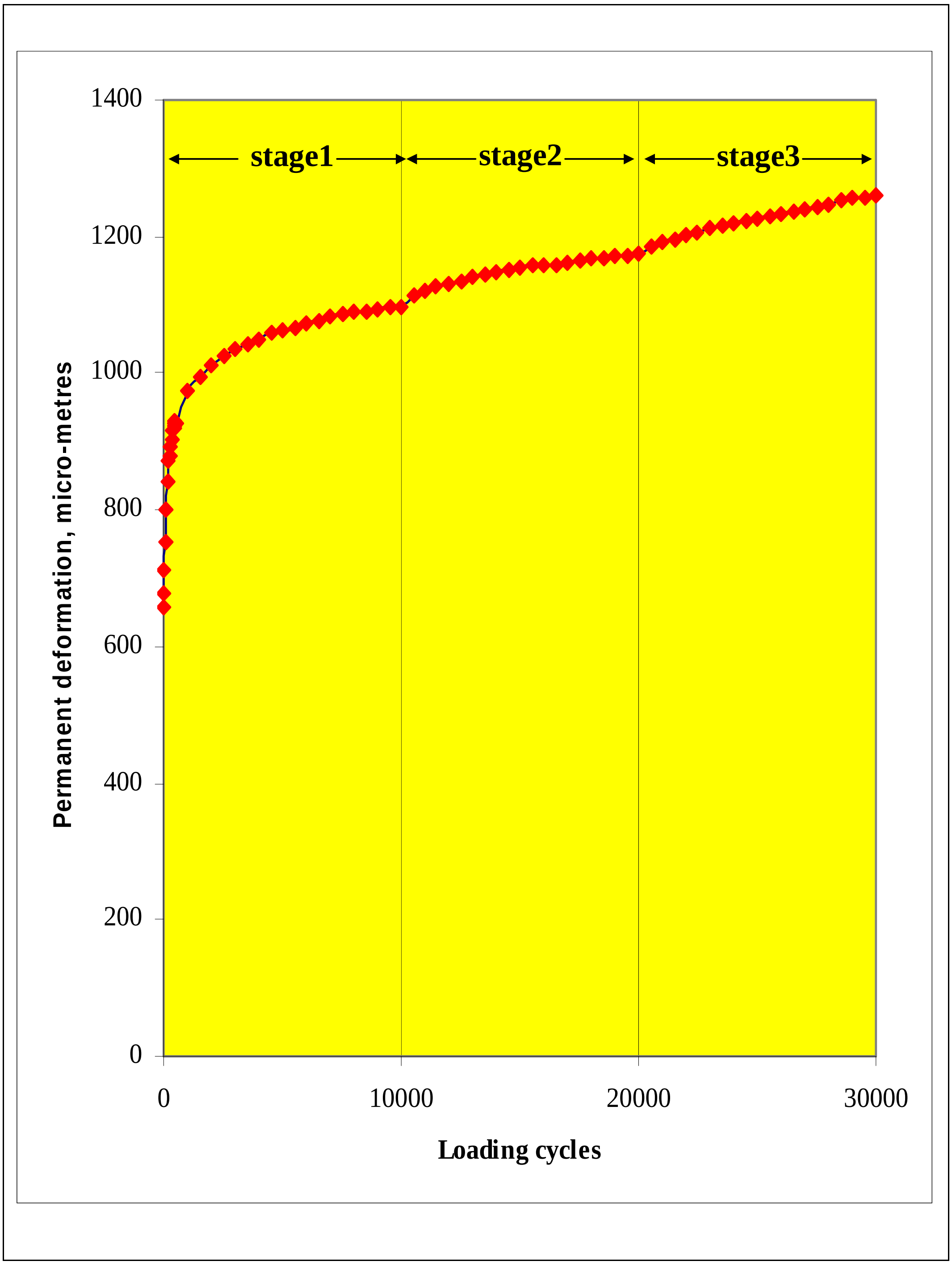


Figure 4.22 Permanent deformation results of stabilised red sand

Reference material (HCTCRB)

The crushed rock, used in this study, was obtained from a local Gosnells Quarry. Crushed rock samples were collected randomly from a stockpile area and kept in sealed plastic containers. Samples were re-checked, at the Department of Civil Engineering, Curtin University of Technology, in the laboratory as to their important properties in accordance with the Crushed Rock Base (CRB) Basecourse Specifications (Main Roads Western Australia, 2003). Figure 4.23 shows the particle size distribution of the crushed rock of this study corresponded to the average particle size of the basecouse specifications. Figure 4.24 exhibits the compaction curve of the studied crushed rock. Comparisons of important properties and specifications were made as shown in table 4.11.

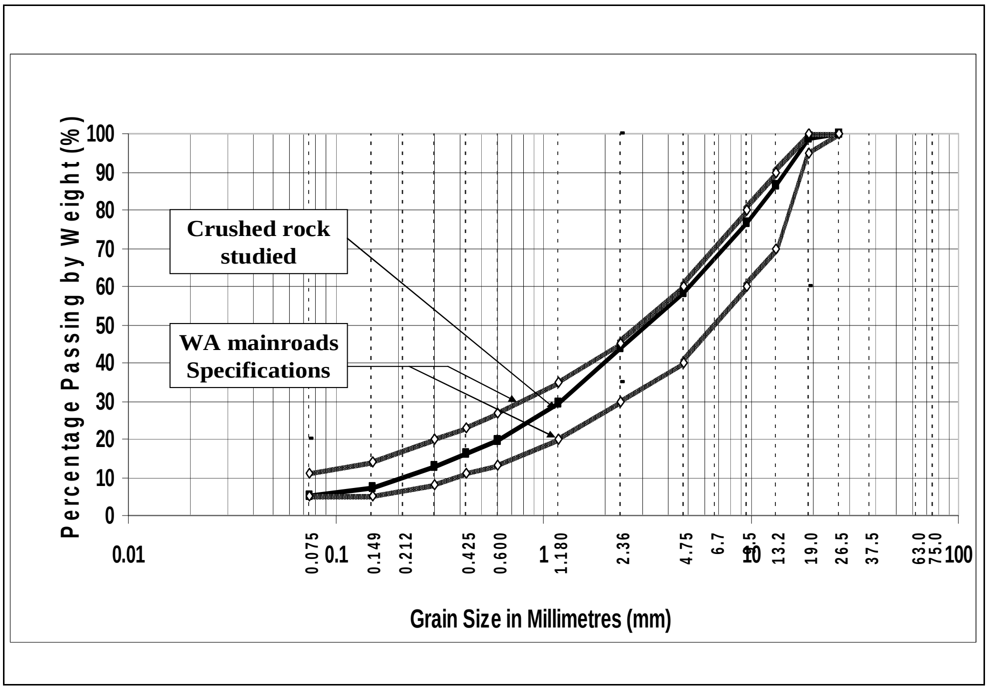


Figure 4.23 The particle size distribution of crushed rock studied comparing with WA mainroads specifications

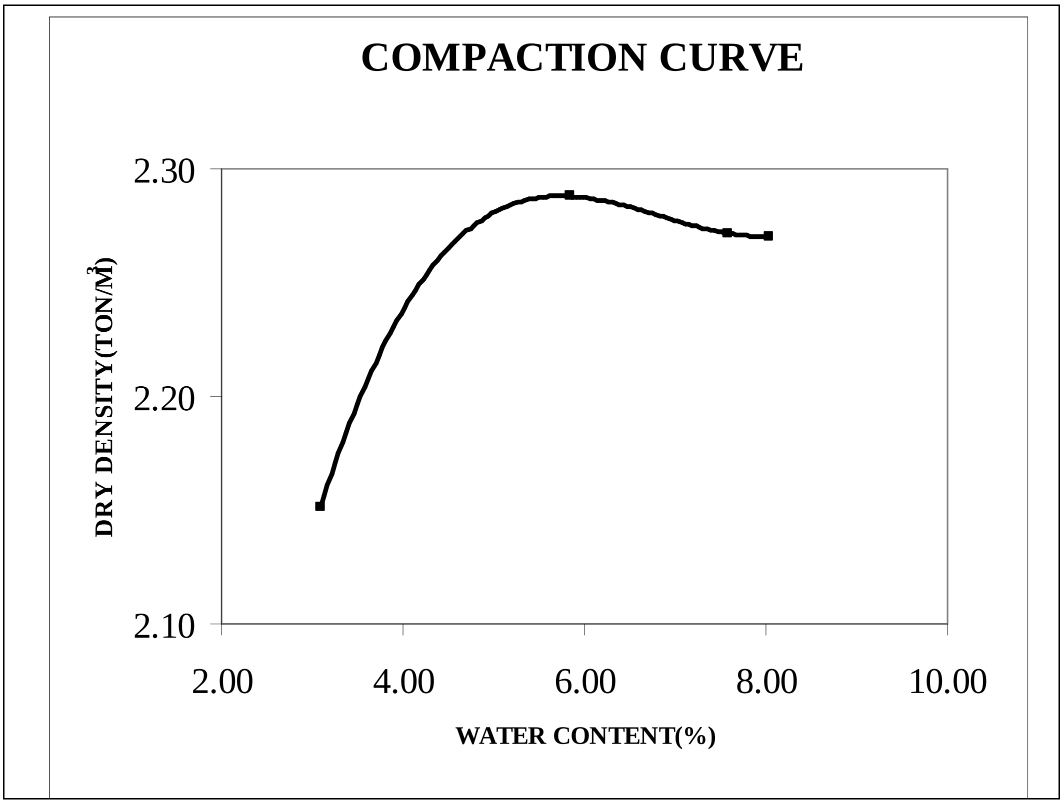


Figure 4.24 The compaction curve of crushed rock material in this study

Table 4.11 The important properties of crushed rock studied

Test Methods*	Tests	Results	Specification
WA 120.2	Liquid Limit, LL	22.4%	<25
WA 121.1	Plastic Limit, PL	17.6%	N/A
WA 122.1	Plastic Index, PI	4.8%	N/A
WA 123.1	Linear Shrinkage, LS	1.5%	0.4-2.0
WA 216.1	Flakiness Index, FI	22.5%	<30
WA 140.1	Max. Dry Compressive Strength, MDCS	3528 kPa	> 1700 kPa
WA 220.1	California Bearing Ratio, CBR	180	80

* test methods in accordance with MRWA Test Method (Main Roads Western Australia, 2006)

- *Static triaxial tests*

Drained triaxial compression tests were conducted to obtain information on the cohesion, c, and the internal friction angle,ϕ, of HCTCRB. The confining pressures of 50 kPa, 100 kPa, and 150 kPa were also applied on the tested specimens in each test. The characteristics of each test are summarised in table 4.12. This should be noticed that the dry unit weight and the water content of HCTCRB were slightly less than the fresh crushed rock values (MDD= 2.27 ton/m^3 at OMC=5.5%) after the 7-day hydration period.

Table 4.12 Characteristics of the static triaxial tests on HCTCRB

Test	Confining pressure (kPa)	Wet unit weight (ton/m^3)	Dry unit weight (ton/m^3)	Water content* (%)
1	50	2.22	2.12	4.52
2	100	2.19	2.09	4.64
3	150	2.19	2.10	4.48

* Water content of the sample after the hydration period of 7 days.

Figure 4.25 depicts the relationship of the deviator stress and the axial strain at the three selected confining pressure of HCTCRB. It can be seen that they also increase with increased confining stresses and result in the strain softening characteristic.

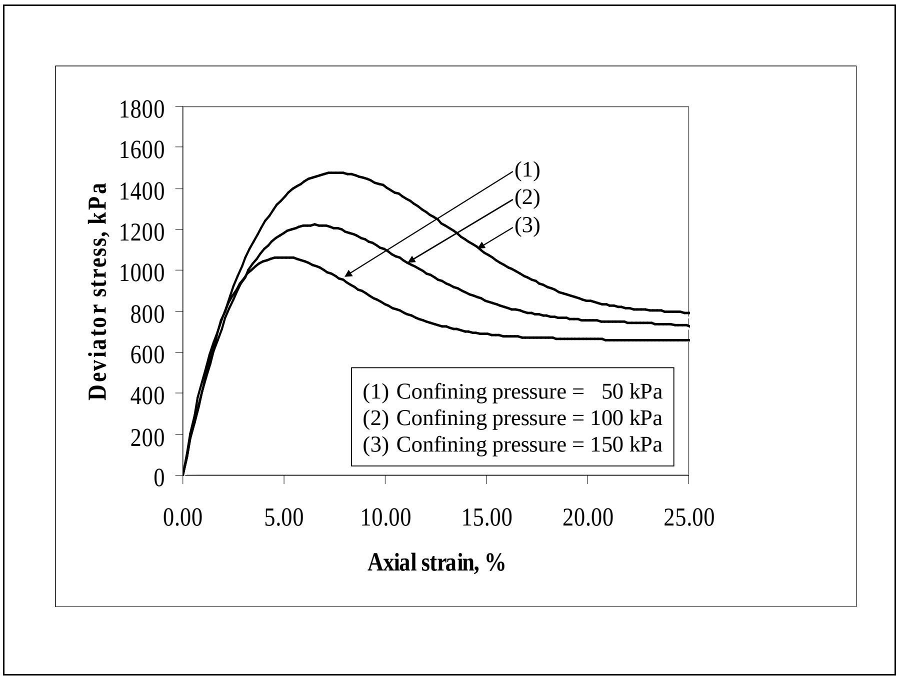


Figure 4.25 The deviator stress with the axial strain for various confining pressure

Figure 4.26 shows the static triaxial test results of HCTCRB on the p-q diagram by means of plan strain conditions. On this diagram, the Mohr-Coulomb failure was defined in terms of principle stresses (principle stresses have been written as σ_1= the major principle stress and σ_2 = the minor principle stress). The deviator stress, q= (σ_1- σ_3)/2, was plotted against the mean applied stress, p = (σ_1+σ_3)/2. The results shown in Figure 4.26 indicate that the Mohr-Coulomb failure envelope (corresponding to the peak stresses) is linear for the stress range tested and has the characteristic in p-q stress space: M_p=q/p=0.729 with a deviator stress intercept, q_c = 104 kPa. In the conventional Mohr-Coulomb stress space, thus the property failure corresponds to an internal friction angle (ϕ) at peak strength of 47° and apparent cohesion (c) of 155 kPa.

The results of the static triaxial test of HCTCRB show that it shows the cohesive granular material behaviour but it is not non-cohesive granular material like materials such as sands and gravels. The behaviour of HCTCRB strongly depends upon both degrees of cohesion and internal friction angle.

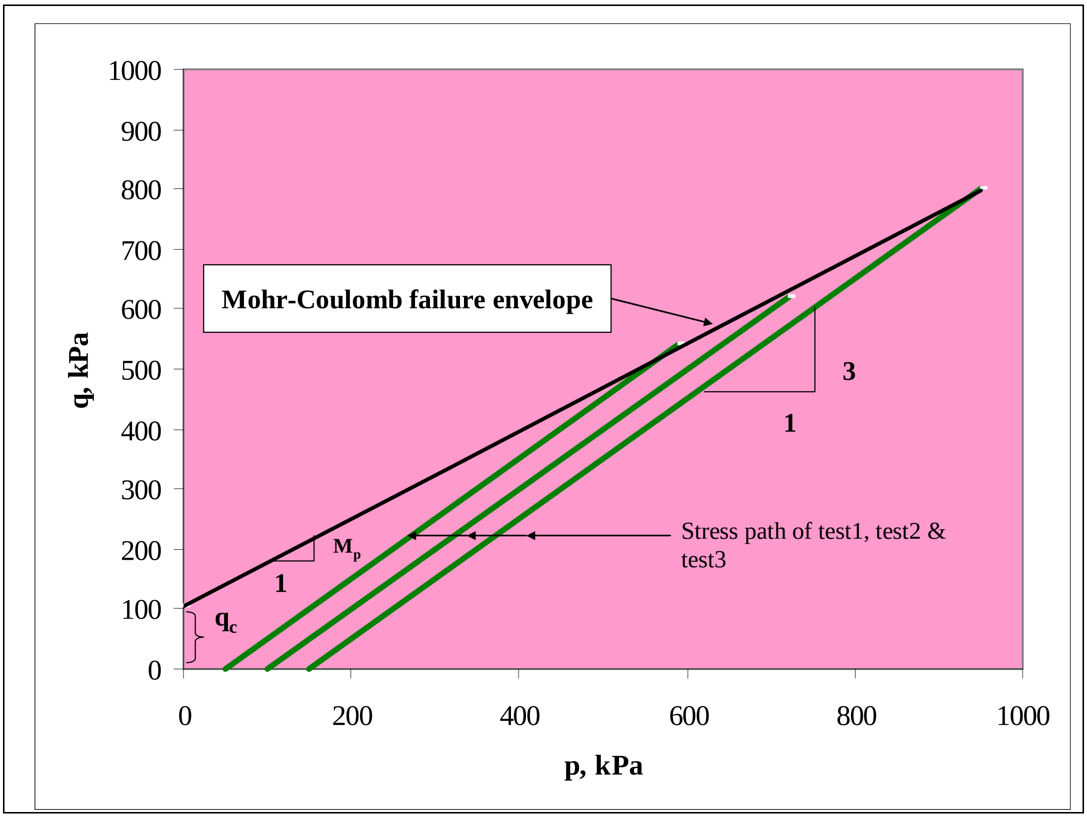


Figure 4.26 Triaxial test results of HCTCRB in p-q stress spaces

- *Resilient modulus tests*

Following the standard test method of Austroad-APRG 00/33 (Voung & Brimble, 2000), in particular HCTCRB, all applied stress conditions are under its Mohr-Coulomb failure envelope in the p-q diagram as shown in Figure 4.27. This means that the tested specimens were not damaged during such testing under the given loading.

Figure 4.28 indicates the HCTCRB resilient modulus results with applied loading sequences.

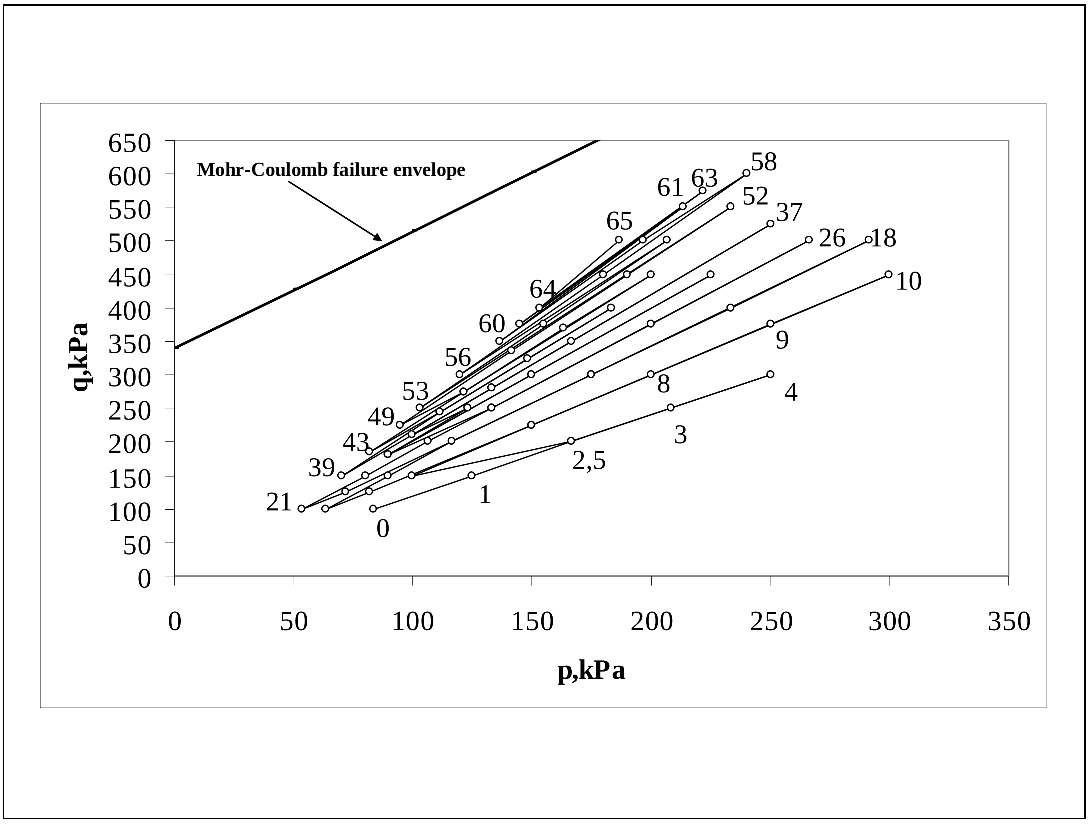


Figure 4.27 Stress conditions applied of resilient modulus tests following Austroad-APRG 00/33 standard in the p-q diagram

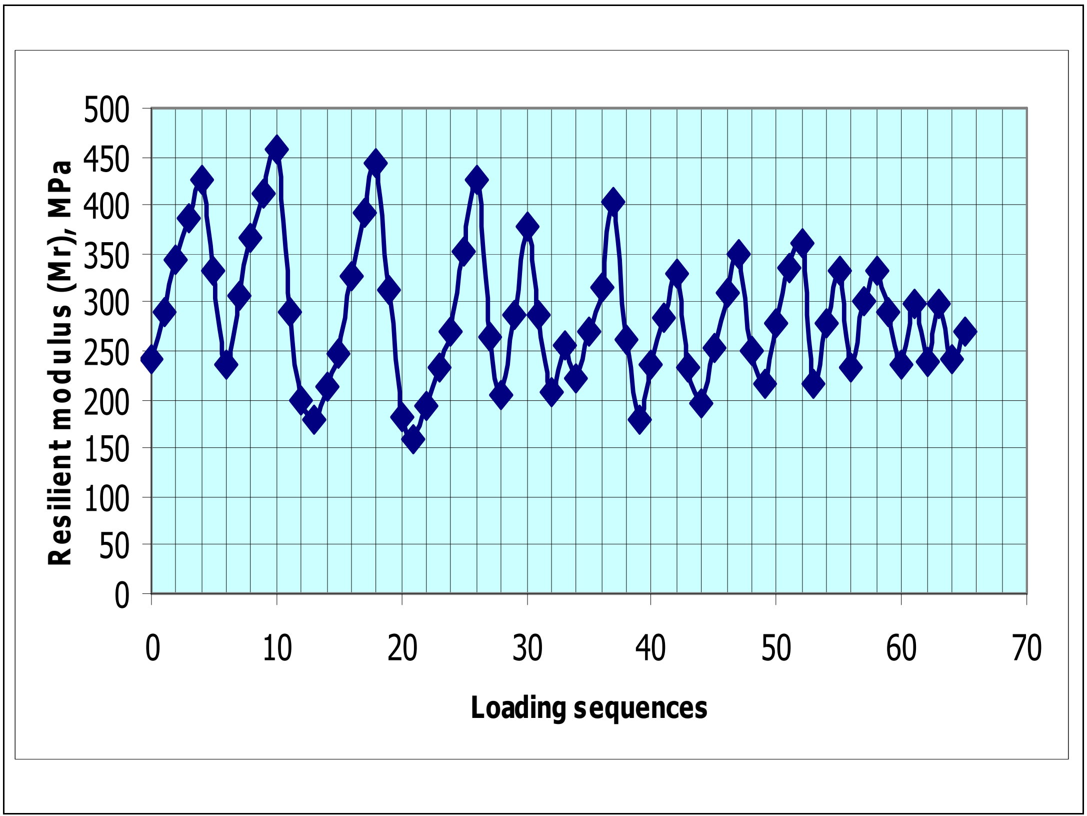


Figure 4.28 Resilient modulus results of HCTCRB

Figure 4.29 shows another form of the results of the resilient modulus plotted against the bulk stress ($\sigma_1+\sigma_2+\sigma_3$). These results were based upon the stress ratios ($\sigma1/\ \sigma3$) which represent to the stress levels acting on the specimen following the loading standard. The stress ratios of the Austroad- APRG 00/33 standard(Voung & Brimble, 2000) are varied from 3 to 26. From these results, it should be noted that at the stress ratio of 16 (applied loading sequences No.56, No. 57, and No. 58), stress softening phenomenon occurs. It is clear that the regression curve based on the resilient modulus data at a stress ratio of 16 trends to go downward for loading sequence No.58, it becomes so high that it is close to failure. It can be seen in Figure 4.27 that loading sequence No.58 is closest to the failure line when compared to the others. This implies that at loading sequence No.58, HCTCRB exhibited the plastic behaviour. For this reason, the resilient modulus results from the stress ratios 17 to 26 (loading sequence No. 59 to No. 65) are lower than otherwise expected because when the materials are beyond plastic behaviour, it is very hard to return to the elastic behaviour in particular the discrete materials such as soils. This is supported by the example results of stress-strain response (200 loading cycles) of loading sequences No.55, No.56, No.58, and No.65 as shown in Figure 4.30. It can be clearly seen that for loading sequence No.55 and No.56 (before the strain softening occurring), HCTCRB shows almost complete hysterical loops that indicate it is being in an elastic behaviour; for loading sequence No.58 and No.65 (after the strain softening occurring), HCTCRB shows plastic strain characteristics with a large amount of permanent strain and a larger band.

All these results indicate that when considering the resilient modulus values, the loading sequence No. 58 to No. 65 of the Austroad- APRG 00/33(Voung & Brimble, 2000) standard cause the unreliable values. Furthermore, HCTCRB in this study can withstand only the applied loads in the maximum level of the stress ratio of 16; if it is subjected to increased loads, it would show plastic behaviour.

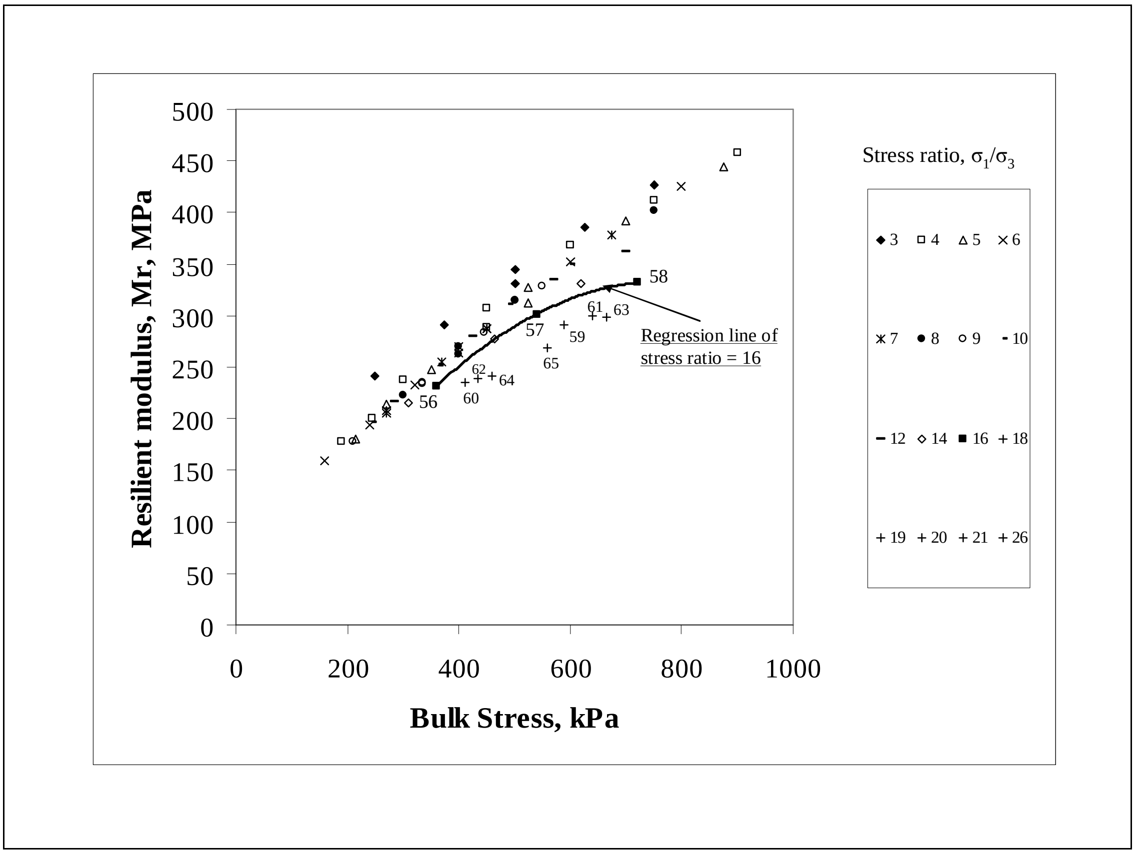


Figure 4.29 The resilient modulus results of HCTCRB with stress ratios

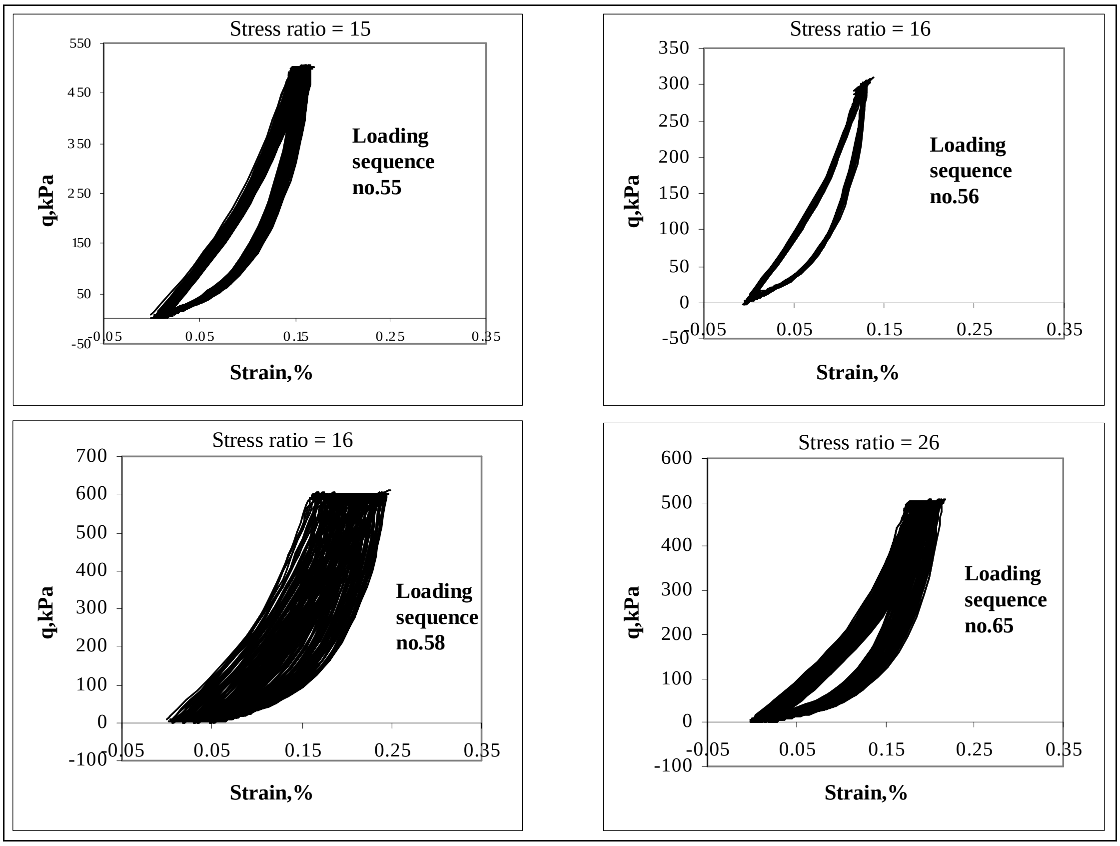


Figure 4.30 Stress-strain responses for 200 loading cycles

The K-Theta (K-θ) model (Hick & Monosmith, 1971) and The Uzan model (Uzan, 1985) are also used to consider significant models for the non-linear behaviour of HCTCRB in this study. Table 4.13 and figure 4.31 show the results of modelling HCTCRB resilient modulus values, after the resilient modulus results of loading sequence No.58 to No.65 were exempted from the considered data, with both models.

Table 4.13 Resilient modulus models for HCTCRB in this study

Model	Equation	The regression coefficients			Symbols
		K_1	K_2	K_3	
K-Theta (K- θ)	$M_r = k_1\theta^{k_2}$ (Hick and Monismith, 1971)	6.317	0.628	-	M_r = Resilient modulus,MPa θ = Bulk Stress = $(\sigma_1+\sigma_2+\sigma_3)$ k_1, k_2= Regression coefficients
Uzan	$M_r = k_1 p_a \left(\frac{\theta}{p_a}\right)^{k_2}\left(\frac{\sigma_d}{p_a}\right)^{k_3}$ (Uzan, 1985)	1.630	0.442	0.019	M_r = Resilient modulus,MPa θ = Bulk Stress = $(\sigma_1+\sigma_2+\sigma_3)$ k_1,k_2,k_3= Regression coefficients p_a = Atmospheric pressure = 100 kPa σ_d = σ_1-σ_3

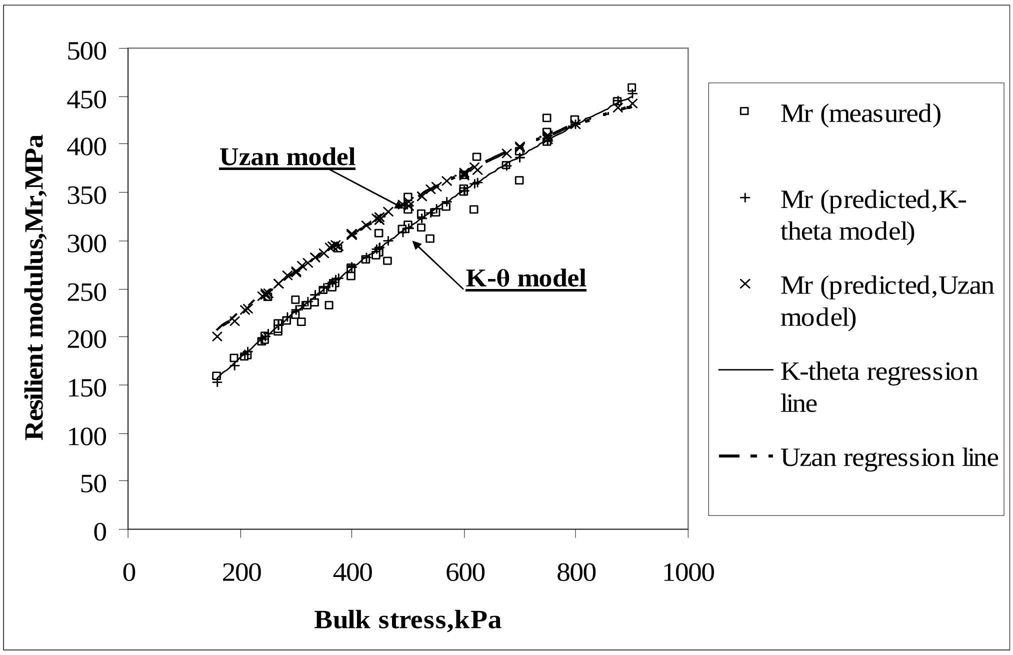


Figure 4.31 The relationship of resilient modulus values and resilient modulus models

- *Permanent deformation tests*

Figure 4.32 shows typical results of the permanent deformation test in terms of the relationship between permanent deformation and loading cycles for HCTCRB. It can be noted from figure 4.32; the permanent deformation of HCTCRB is not dominated by the applied load in the testing range because when loads increase from stage 1 to stage 3, the permanent deformation of HCTCRB does not increase dramatically. In contrast, the number of loading cycles seems to influence to the permanent deformation values.

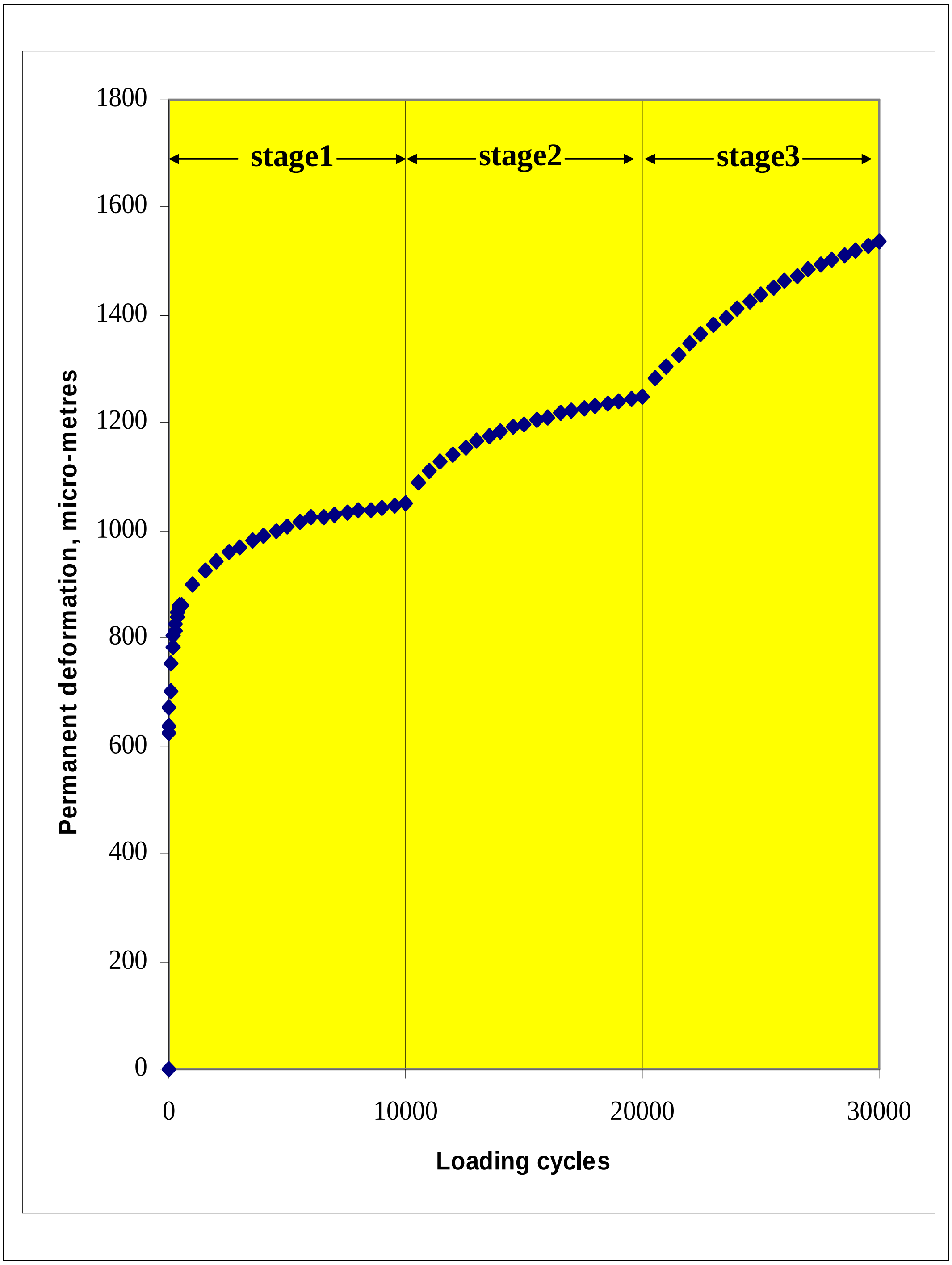


Figure 4.32 The permanent deformation test results of HCTCRB

A comparison of all testing results between stabilised red sand and HCTCRB in the verification stage

The main objective of verification is to prove whether the stabilised red sand, derived from the best mix design, could display the significant characteristics-strength, resilient modulus, and permanent deformation- as a commonly used road base material (HCTCRB). In this section, a comparison of those characteristics is presented.

- *Strength*

When considering the shear strength parameters (c and ϕ) of stabilised red sand and HCTCRB, it was found that stabilised red sand has better cohesion (c) and HCTCRB has a better friction angle (ϕ) as depicted in table 4.14. However, as shown in figure 4.33, Mohr-Coulomb failure envelopes in the p-q diagram of stabilised red sand and HCTCRB perform very closely. In the range of p of 0 to 250, stabilised red sand shows up slightly better, but after p of 250 kPa, HCTCRB is more dominant.

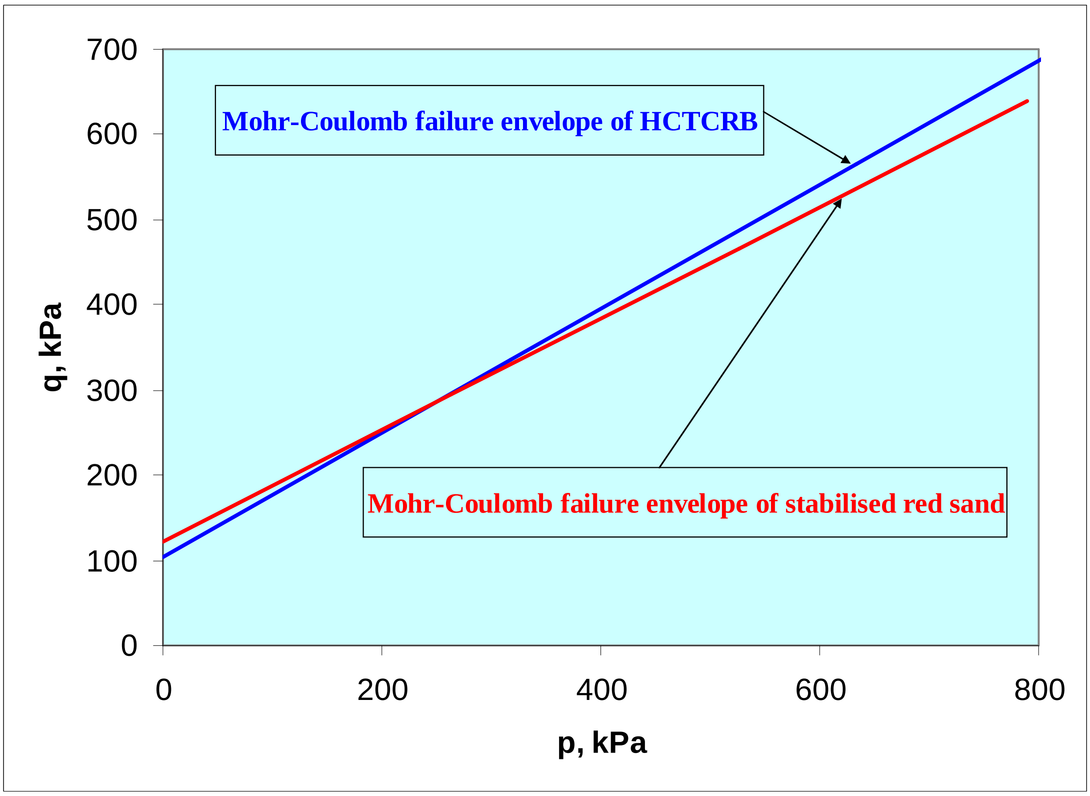


Figure 4.33 A comparison of stabilised red sand and HCTCRB failure envelopes

- *Resilient modulus*

Figure 4.34 shows the comparison of resilient modulus testing results between HCTCRB and stabilised red sand. It can be clearly seen that based on the standard of Austroad-APRG 00/33(Voung & Brimble, 2000), stabilised red sand demonstration resilient modulus characteristics more significantly than HCTCRB.

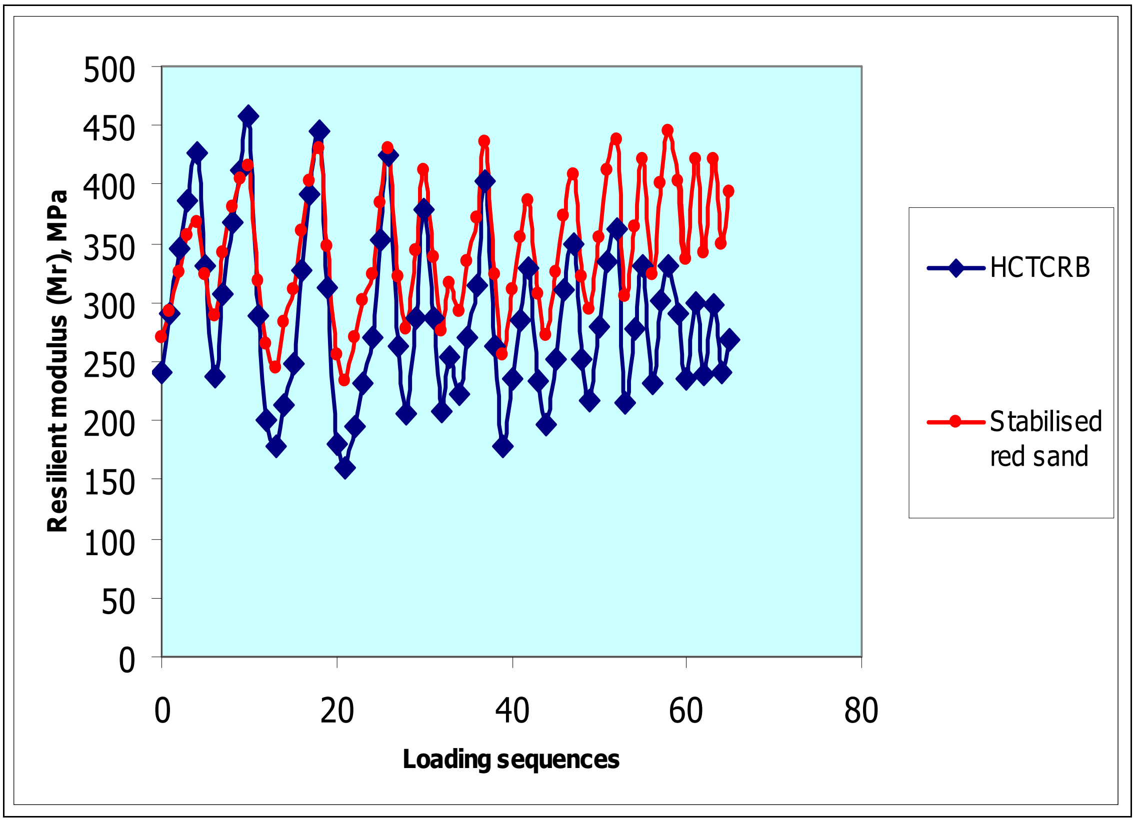


Figure 4.34 Comparison of the resilient modulus results of stabilised red sand and HCTCRB

- *Permanent deformation*

Figure 4.35 exhibits the comparison of permanent deformation testing results between HCTCRB and stabilised red sand. In accordance with the standard of Austroad-APRG 00/33(Voung & Brimble, 2000), stabilised red sand show permanent deformation characteristics more significantly than HCTCRB.

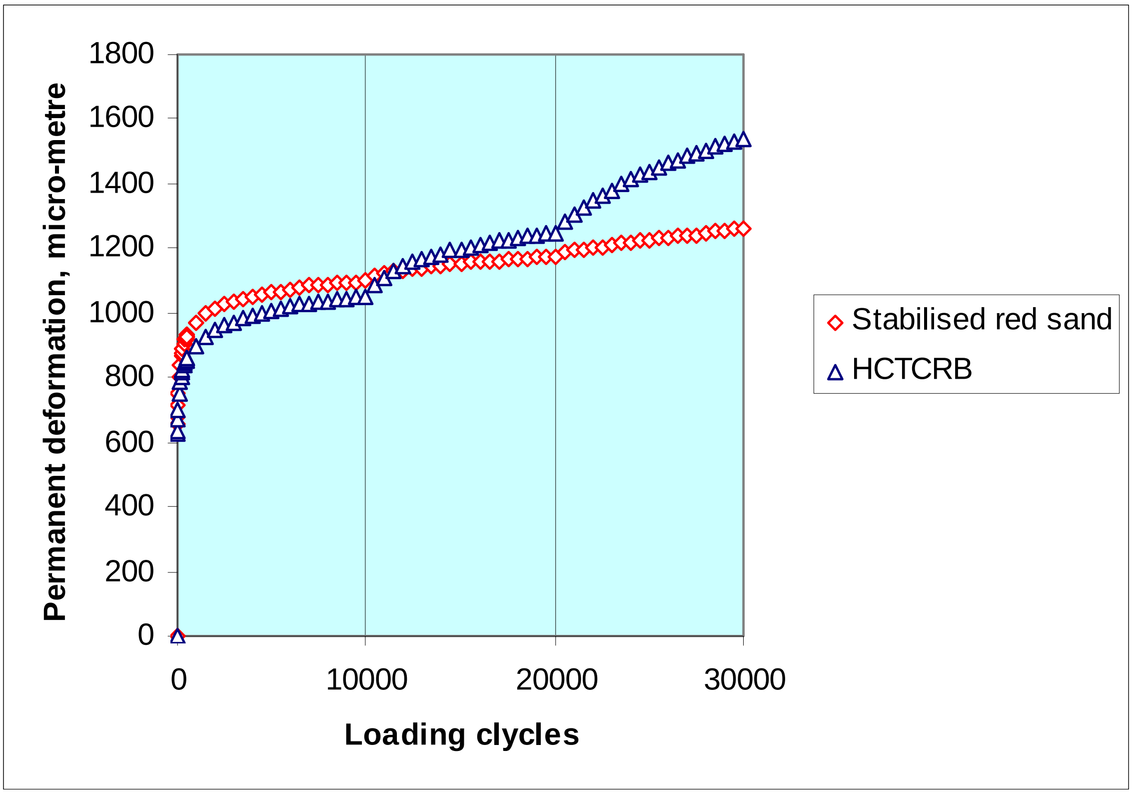


Figure 4.35 Comparison of the permanent deformation results of stabilised red sand and HCTCRB

4.4 Part 3: Red sand for embankments

4.4.1 Out line

The representative stabilised red sand sample which were subjected to the tests presented in this section were the mixtures of 70% red sand, 25% fly ash, and 5% lime kiln dust (LF ratio 1:5) by dry weight. The results indicate it would be applicable to embankment design as the experiments focused on strength, permeability, and consolidation.

The conventional consolidated drained triaxial test was utilised to determine the strength characteristics of such material. For consolidation characteristics, the triaxial consolidation was selected to examine the stabilised red sand compressibility. The indirect method of determining the coefficient of permeability of stabilised red sand was employed by using the equation, proposed by Terzaghi, (1943), which is based upon the consolidation parameters from the triaxial consolidation and some of which were modified and proposed by Head (1980).

4.4.2 Laboratory testing of red sand for embankments

Strength

Figures 4.35(a) and 4.35(b) depict the relationship of the deviator stress versus the axial strain and the volume strain versus the axial strain at the three confining pressures, respectively. In figure 4.36(a), it can also be seen that the deviator stress increases with increased the axial strain until it reaches the peak strength of all confining pressures. Furthermore, higher confining pressure shows higher peak strength. All three curves in Figure 4.36(a) exhibit the strain-softening phenomenon, like a dense granular material. As mentioned in the red sand for road bases section, for stabilised materials in particular a cement stabilisation material, the stress-strain relationships usually perform as brittle materials but the stabilised red sand shows the strain softening characteristic even if it was in the completely saturated condition. Figure 4.36(b) shows the volume change characteristics of these tests. The volumetric strain versus axial strain from a series of consolidated drained triaxial tests under different confining pressures on the specimen is presented in figure 4.36(b). The signs for the volumetric strain are negative for compression and positive for dilation. From the results, it can be seen that the volumetric strains of the specimens exhibit similar characteristics. The specimens compress in the early stage of shearing and then dilate afterwards. Moreover, the specimens perform a high dilatancy. As a result, the dilation of the stabilised red sand during shearing increases with increased axial strains. It also can be seen that the higher the confining pressures perform the higher volumetric strains occur at the same axial strain. The volumetric strain reaches a maximum compression stress when the soil specimen reaches the yield condition and then becomes essentially constant indicating the critical state condition. These volume change characteristics are identical to those of a theoretical dense cohesionless soil subjected to the same test.

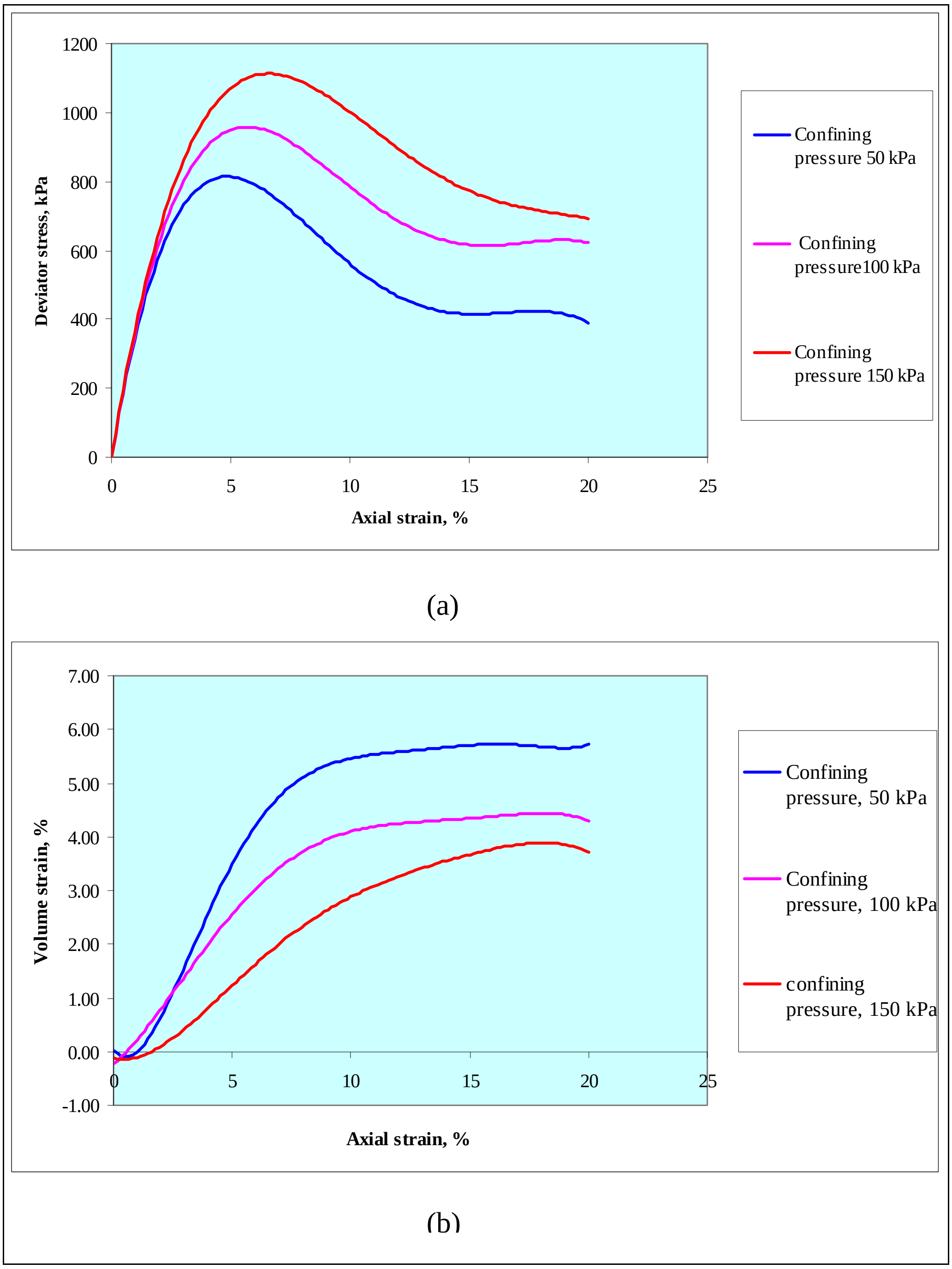


Figure 4.36(a) and (b) The consolidated drained triaxial test results of stabilised red sand for embankments

Figure 4.37 shows Mohr's circles and Mohr-Coulomb failure envelope of these tests. The results show an internal effective friction angle (ϕ') at peak effective strength of 38° and apparent effective cohesion (c') of 157 kPa.

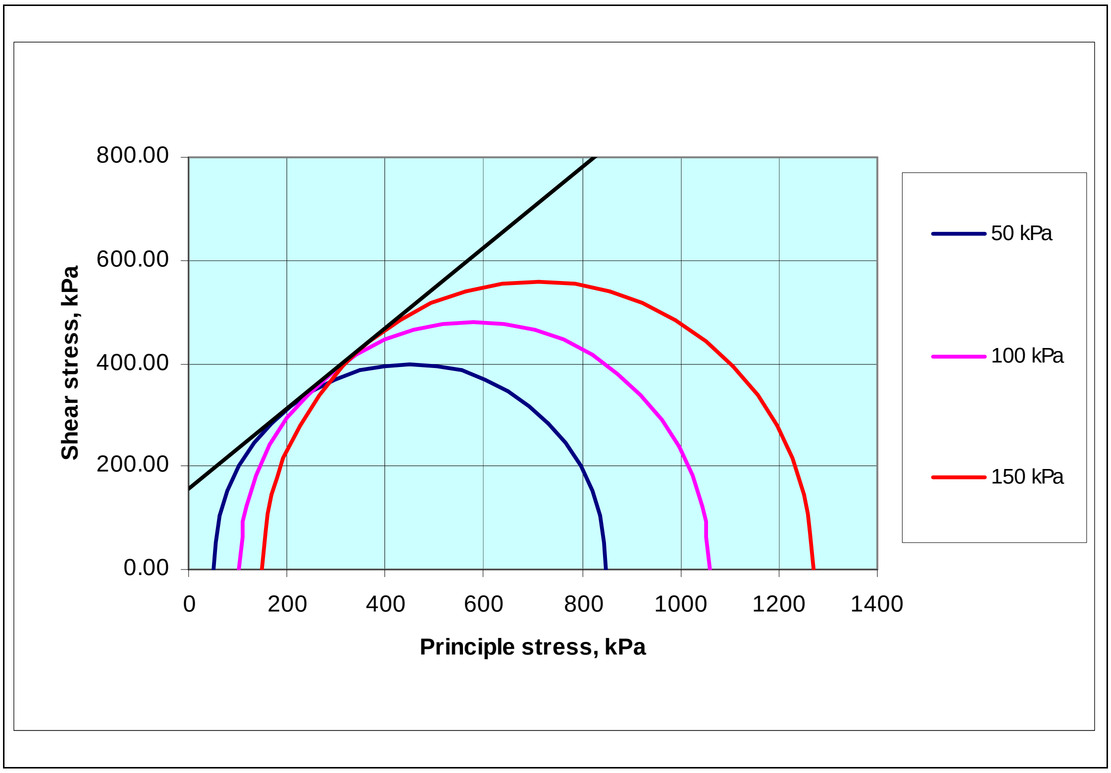


Figure 4.37 Mohr's circles and Mohr-Coulomb failure envelope of consolidated drained triaxial tests of stabilised red sand for embankments

Consolidation

The results of the isotropic triaxial consolidation test performed on the stabilised red sand specimen are shown in figure 4.38 in the form of traditional plots of void ratio (e) versus logarithm of the isotropic consolidation pressure (σ'_p), or e- logσ'_p

curve as performed as curve ABC in figure 4.38. It can be seen that the compression curve of this test, curve ABC, tends to perform in straight line portions: the first, from A to B is usually named the *recompression curve*, and soil behaviour is assumed to be non linear but almost completely reversible along this path; the second portion, from B to C, is called the *compression curve*, and is characterised by largely irreversible strains. Moreover, due to the effect of compacting on the tested specimen which was achieved 95%MDD of the mixtures, the pre-consolidation stress, p_c is evident as 120 kPa. The experimental data presented in figure 4.38 denote a break point, is the pre-consolidation stress (120 kPa) that separates elastic behaviour from irreversible behaviour. The compression index, C_c of 0.0186 was determined from the appropriate portion of the e- $\log\sigma'_p$ curve in figure 4.38.

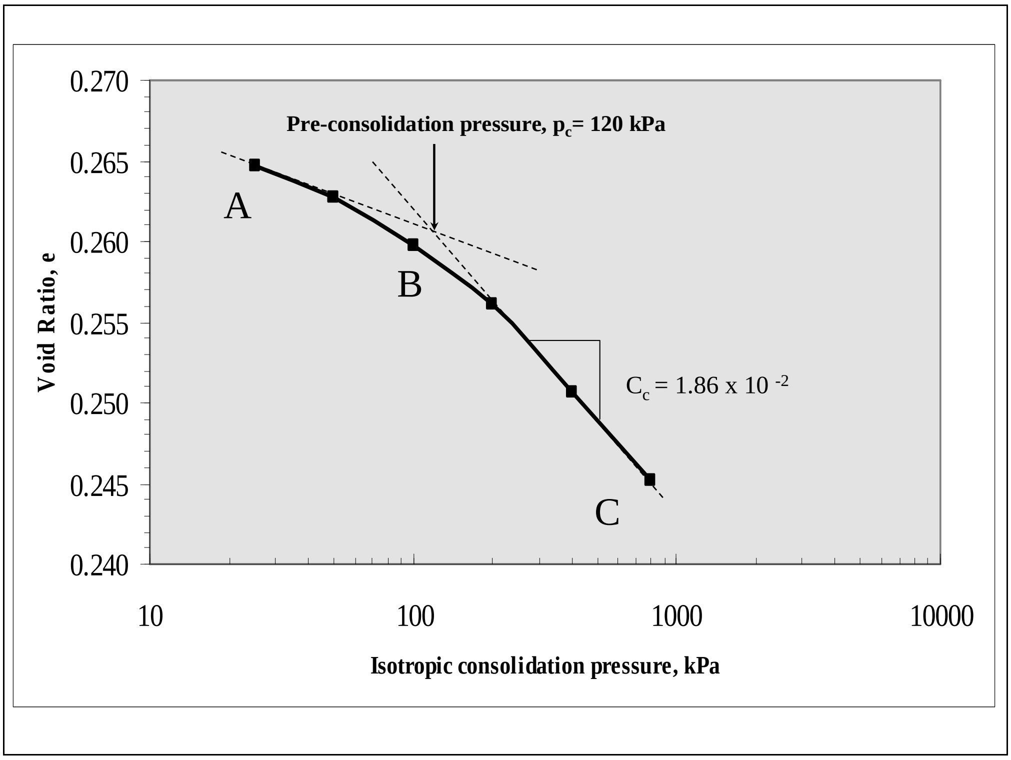


Figure 4.38 The results of the traxial consolidation test on the stabilised red sand

Coefficients of consolidation, Cv, are plotted as functions of isotropic consolidation pressure in figure 4.39. It has to be noted that the Cv, presented in this section is determined from the consolidation stage data by using a procedure similar to the conventional method of Taylor's (square-root-time) method. The volume of water draining out of the sample during consolidation which was equal to the sample volume change for a saturated sample is recorded and plotted against square-root time (minutes) as indicated in figure 4.40 to find out the time representing theoretical 100% consolidation, t_{100} (Head, 1980). The value of Cv can then be calculated from the following equation:

$$C_v = \frac{\pi D^2}{t_{100}} \qquad (4.1)$$

Where D is the diameter of sample measured in mm

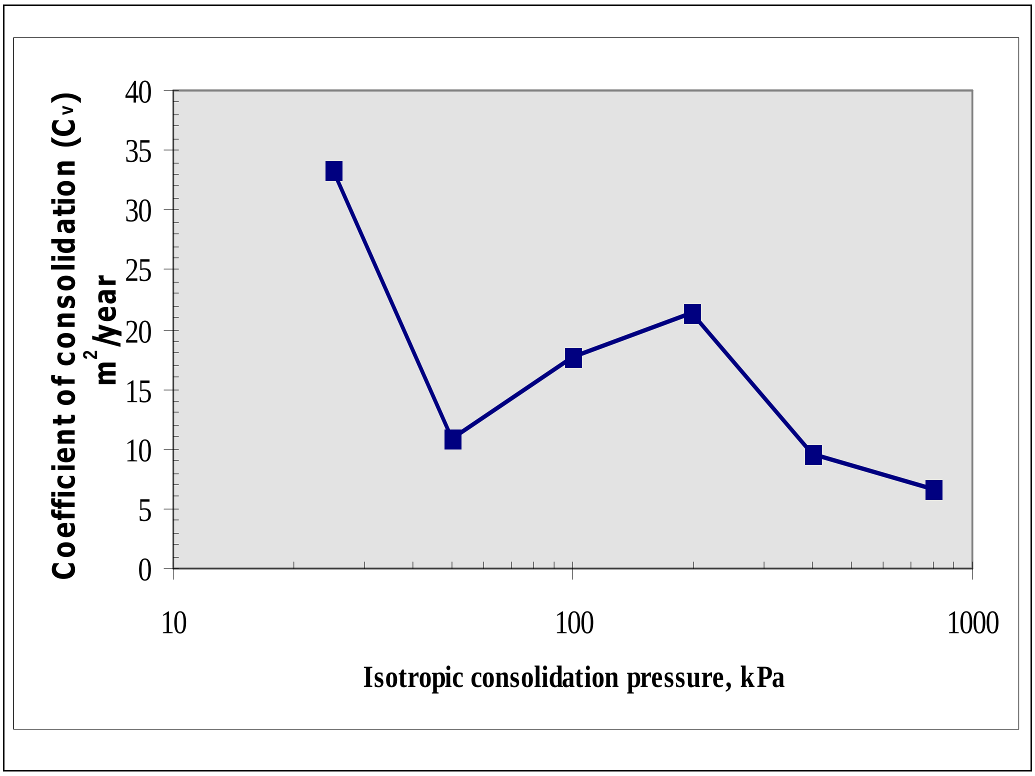


Figure 4.39 Coefficient of consolidation as function of isotropic consolidation pressure from the triaxial consolidation test

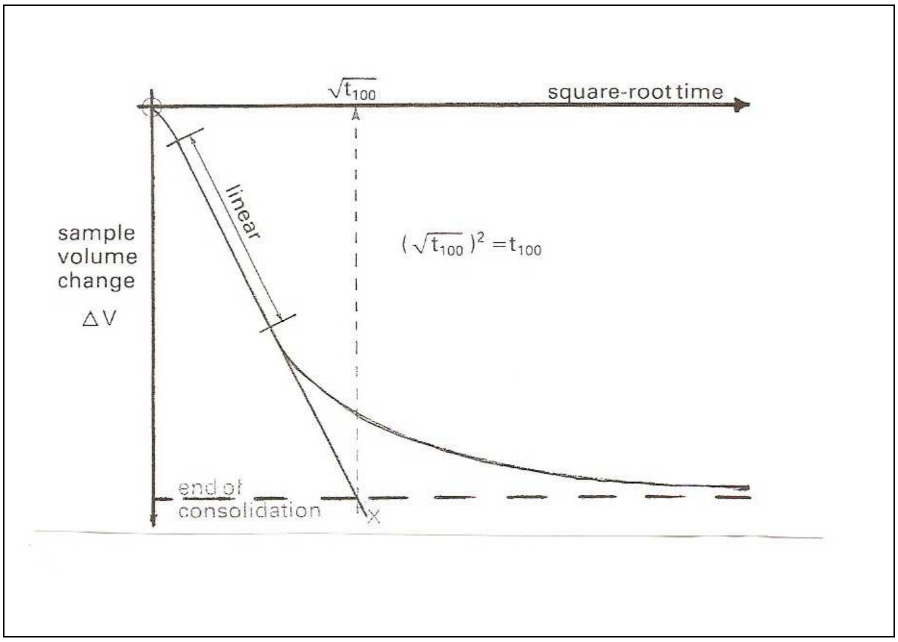


Figure 4.40 Determination of theoretical t_{100} from volume change square-root time consolidation curve for triaxial samples (Head, 1980)

Permeability

In figure 4.41, calculated hydraulic conductivity or coefficient of permeability (k) values and coefficient of volume compressibility (m_{vi}) are plotted versus isotropic consolidation pressures for stabilised red sand on the triaxial consolidation test. Coefficient of permeability of stabilised red sand is in the range from 3.22 x 10^{-11} m/s to 6.34 x 10^{-10} m/s of the isotropic consolidation pressures from 50 kPa to 800 kPa. From these values, it can be concluded that stabilised red sand is a practically impermeable material (k less than 10^{-7} cm/s).

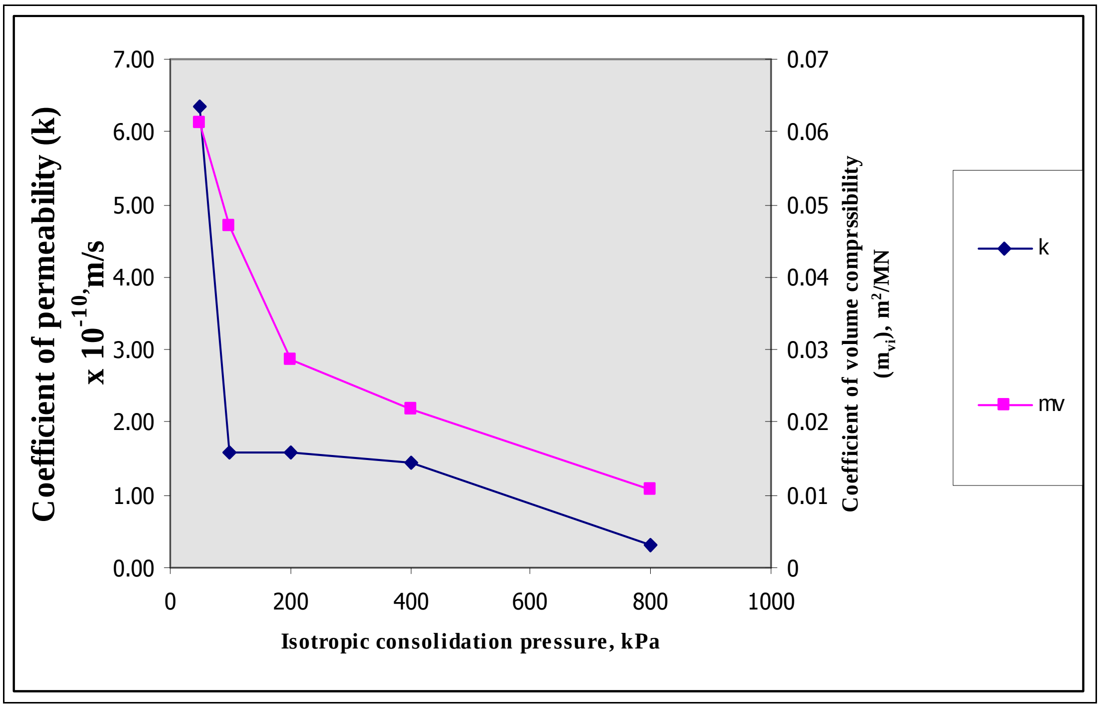


Figure 4.41 Coefficient of permeability and coefficient of volume compressibility of stabilised red sand from triaxial consolidation test results

However, from the values in figure 4.41, it should be noted that the coefficient of permeability values are calculated from the equation which was proposed by (Head, 1980):

$$k = c_v m_{vi} x 0.31 x 10^{-9} m/s \tag{4.2}$$

m_{vi} is the coefficient of volume compressibility which can be calculated from the equation:

$$m_{vi} = \frac{\Delta V_c}{V_s} x \frac{1000}{\Delta\sigma'} m^2 / MN \tag{4.3}$$

Where $\Delta\sigma'$ = the change in effective stress

ΔV_c = the volume change

ΔV_s = the volume of a tested sample

4.5 Part 4: Red sand for seawall fills

4.5.1 Out line

This section presents the results of washed and carbonated red sand which has been subjected to permeability tests, consolidation tests, and strength tests (by consolidated drained triaxial tests) to quantify its permeability, consolidation, and strength characteristics. The reference material (Perth sand), usually employed for a backfill material was used to find the strength properties.

4.5.2 Laboratory testing of red sand for seawall fills

Consolidation

The results of the consolidation tests performed on washed and carbonate red sand specimen are illustrated in figure 4.42 in the graph of traditional plots of void ratio (e) versus logarithm of the effective consolidation pressure. From this graph, it can be seen that due to the tested specimen were remoulded, a pre-consolidation stress is not evident in the loading portions of the e-log σ' curve. The compression index, Cc, was also determined from the appropriate portions of the e-log σ' curve in figure 4.42. The compression index, C_c, of washed and carbonated red sand at 95%MDD and 100%OMC on the traditionally one-dimensional consolidation test was 1.08 x 10^{-2}.

The coefficient of consolidation, Cv, based on Taylor's (square-root time) method is plotted as a function of effective consolidation pressures in figure 4.43. In this test, Cv increases with an increase in effective consolidation pressure (σ'). The increase Cv with σ' in figure 4.43 may seem counterintuitive because Cv would be proportional to the coefficient of permeability (k) and k is expected to decrease with increased σ'. However, Cv is also inversely proportional to the coefficient of volume change, m_v, which also decreases in m_v with increasing σ' (Duncan, 1993). Consequently, if the decrease in m_v with increasing σ' is greater relative to that for k, then an overall increase in Cv with stress is expected. Cv from this test is in the range of 0.18 m^2/year to 0.59 m^2/year increasingly. Typical values for Cv range from about $1x10^{-8}$ m^2/s to about 3.5 x 10^{-6} m^2/s (Lamb & Whitman, 1979). As shown in figure 4.43, the range in Cv values measured in this study conforms well with the range of Cv values reported in the literature.

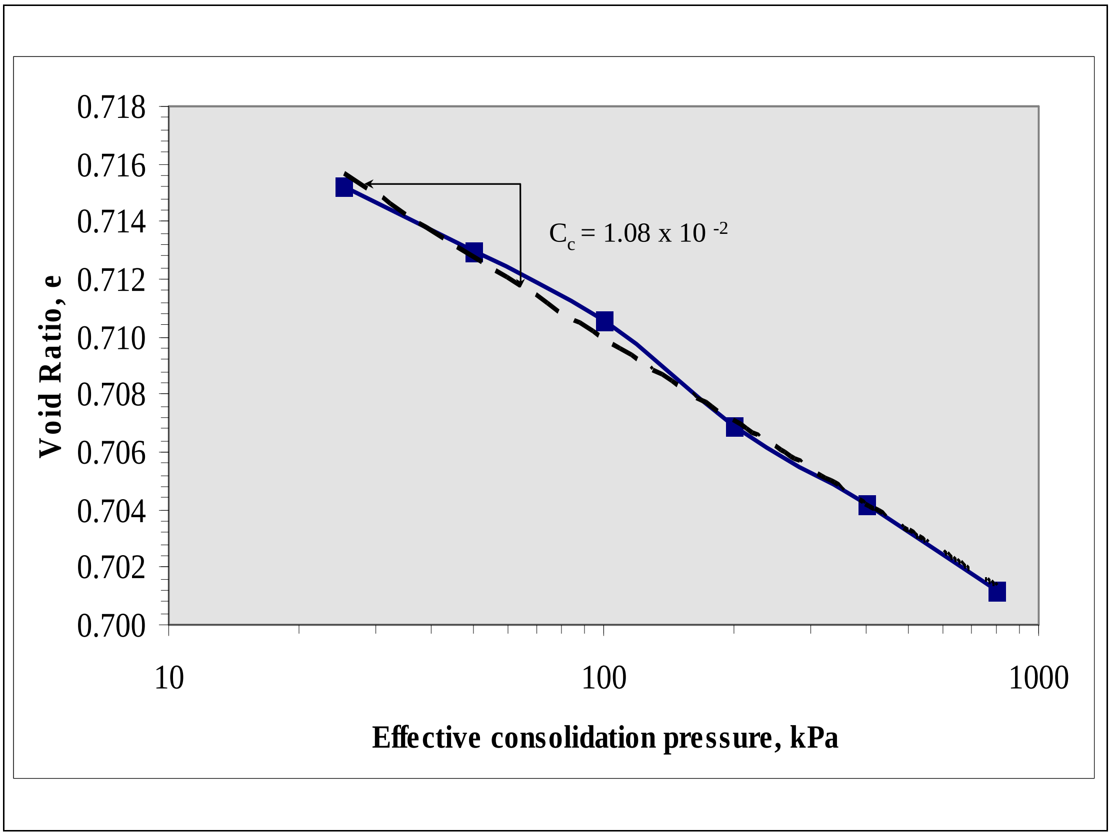


Figure 4.42 Effective consolidation pressures versus void ratio for washed and carbonated red sand from one-dimensional consolidation test

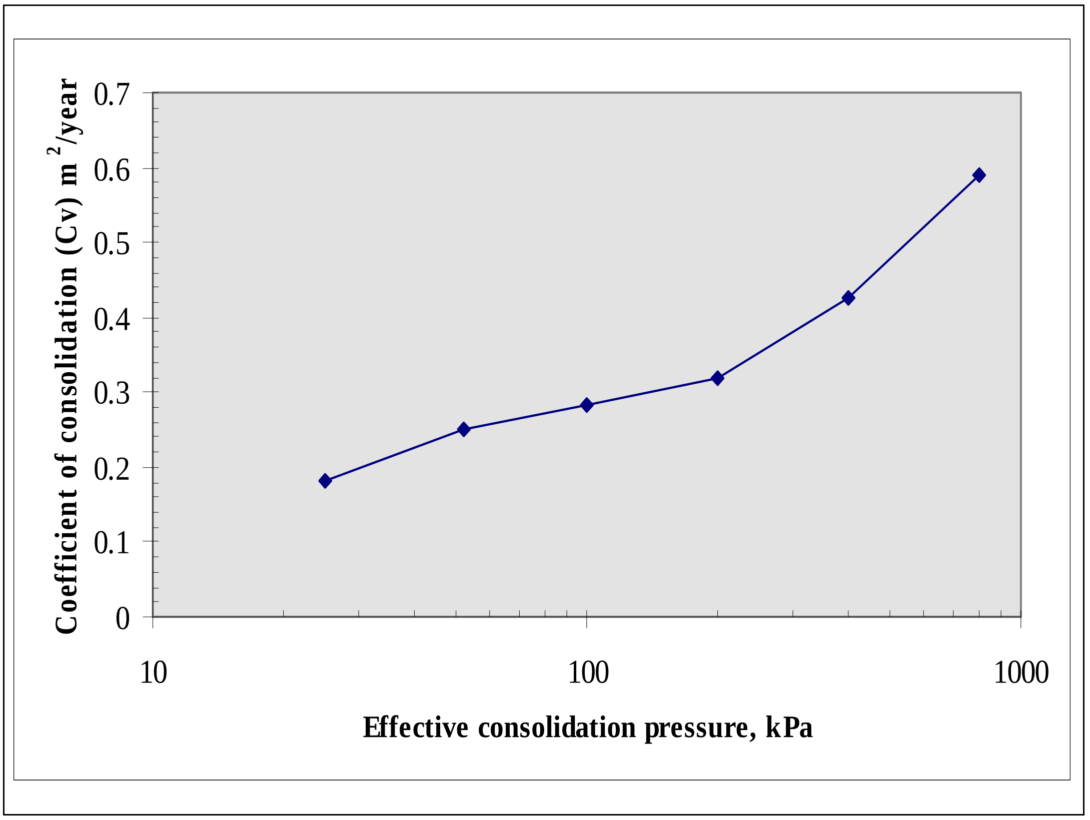


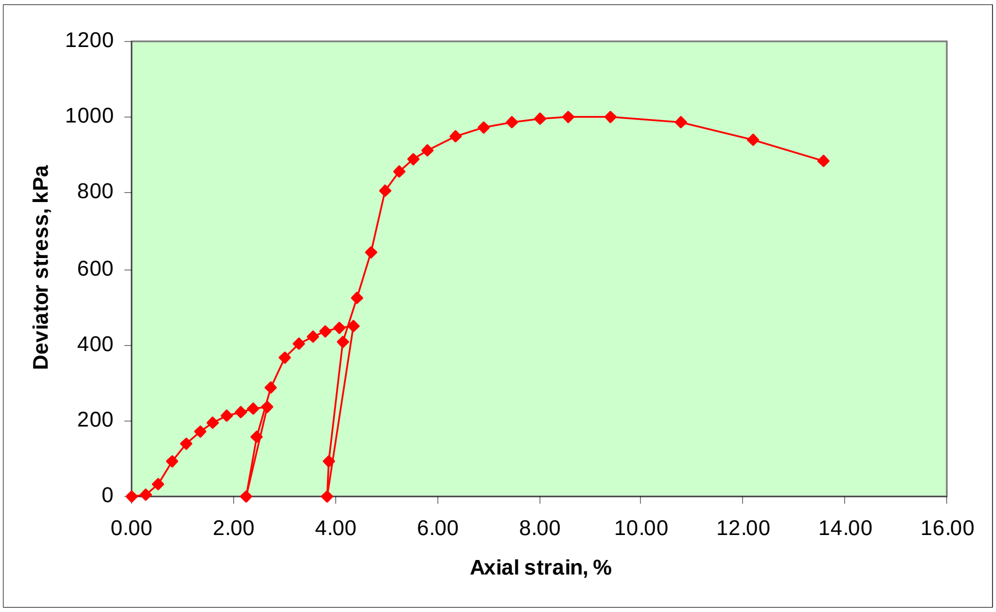
Figure 4.43 Coefficient of consolidation as function of effective consolidation pressures on washed and carbonated red sand

Strength

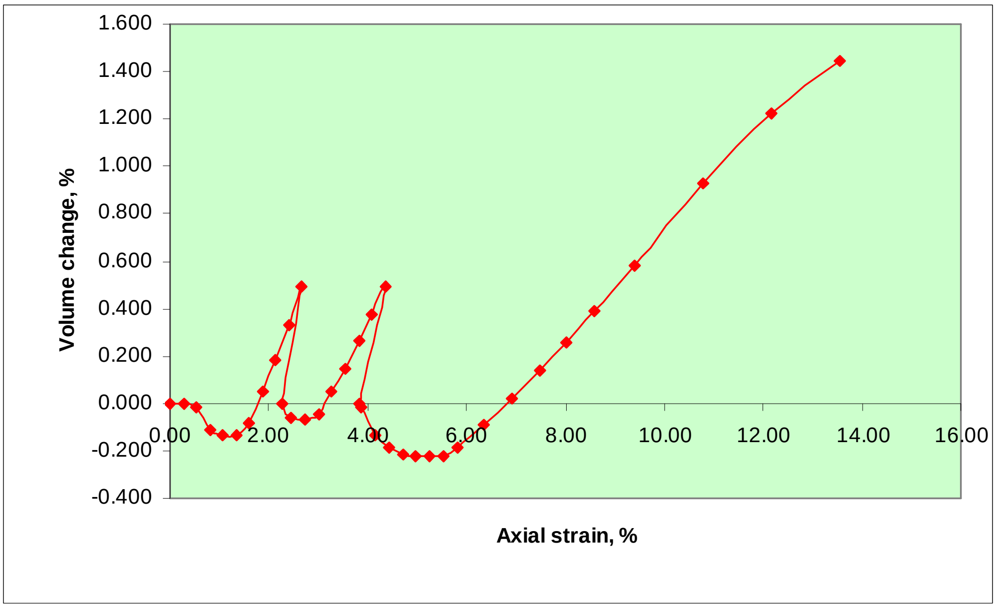
Table 4.14 shows the conclusion of test results from the multistage triaxial tests on Perth sand and washed and carbonated red sand. Figures 4.44 and 4.45 illustrate the stress-strain curve and the volume change curve (the plot of volumetric strains against axial strains) of washed and carbonated red sand and Perth sand, respectively. The aim of the multistage triaxial test is only to determine the effective shear strength parameters (cohesion, c′ and friction angle,ϕ') of the material for guiding design parameters of washed and carbonated red sand as a seawall fill material. The volume change curve from these tests does not show the volume change characteristic representatively because the tested samples were isotropically compressed successively in the consequent stage of tests. However, the volume change characteristic can be useful to make a decision where the peak point in each stage would be reached.

Table 4.14 The multistage triaxial test results of Perth sand and washed and carbonated red sand

Materials	Confining Pressure, σ_3 kPa	Max.deviator Stresses, σ_d kPa	Major.Principle Stresses, σ_1 kPa	$q=(\sigma_d/2)$ kPa	$p=(\sigma_1+\sigma_3)/2$ kPa
Perth sand	100	274	374	137	237
	200	576	776	288	488
	300	860	1160	430	730
Washed & Carbonated Red sand	50	240	290	120	170
	100	440	540	220	320
	250	1020	1270	510	760

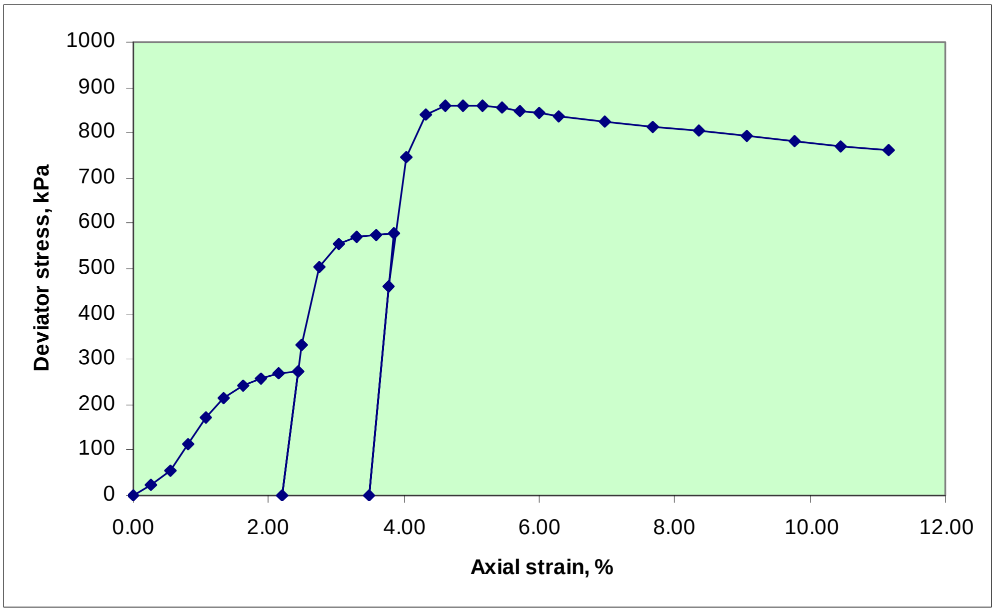


(a)

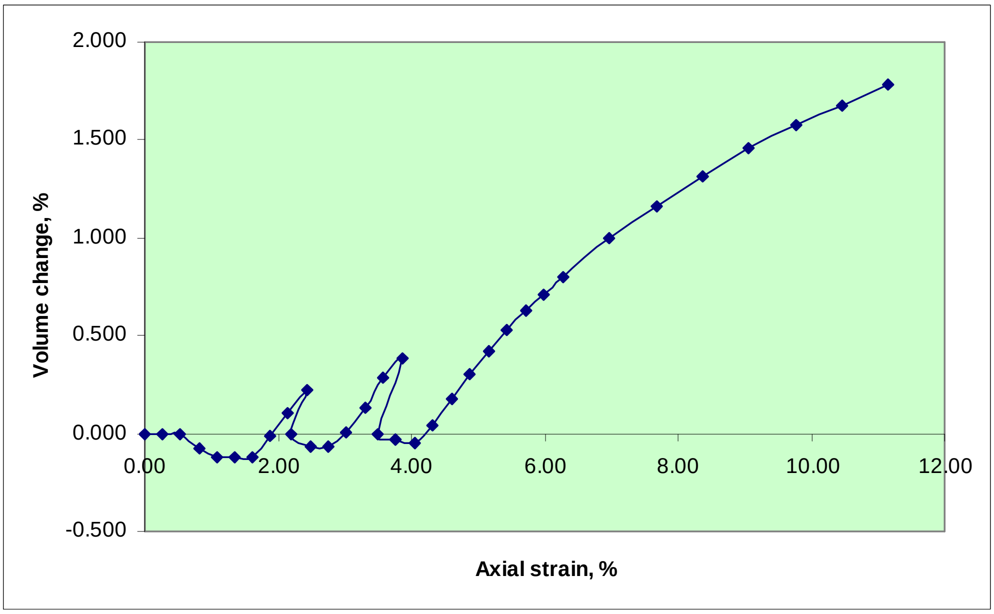


(b)

Figure 4.44(a) The stress-strain curve of washed and carbonated red sand: (b) the volume change curve of washed and carbonated red sand



(a)



(b)

Figure 4.45 (a) The stress-strain curve of Perth sand: (b) the volume change curve of Perth sand

Figure 4.46 shows Mohr's circles and the Mohr-Coulomb failure envelope of these tests and indicate that the Mohr-Coulomb failure envelope (corresponding to the peak stresses) is linear for the stress range tested and in the conventional Mohr-Coulomb stress space. The properties failure correspond to an effective friction angle (ϕ') at peak strength of 41.34° for red sand and of 36° for Perth sand. The apparent effective cohesion (c') is evident only in washed and carbonated red sand of 10.78 kPa.

When considering the effective shear strength parameters (c' and ϕ') of washed and carbonated red sand and Perth sand, it is obvious that red sand performs better in terms of effective cohesion (c') and effective friction angle (ϕ') as depicted in figure 4.46. This can be supported by the comparison of failure envelopes as shown in figure 4.47, Mohr-Coulomb failure envelopes in the p-q diagram of red sand perform more significantly than Perth sand. This means that in all applied loading ranges (0 kPa < p< 800 kPa), red sand has a larger possible zone (the area under the failure envelope) than Perth sand.

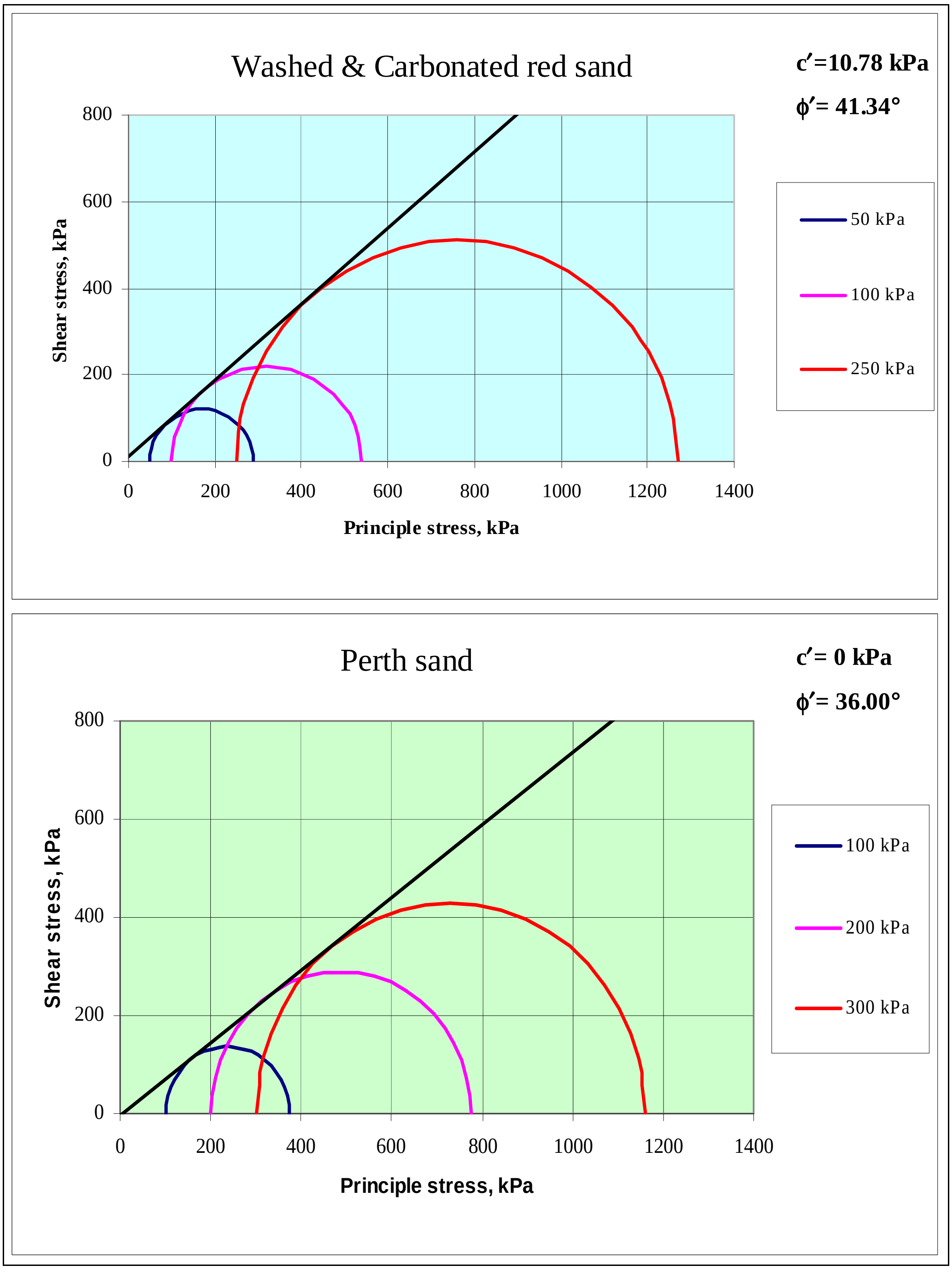


Figure 4.46 Mohr's circles and Mohr-Coulomb failure envelope of washed and carbonated red sand and Perth sand

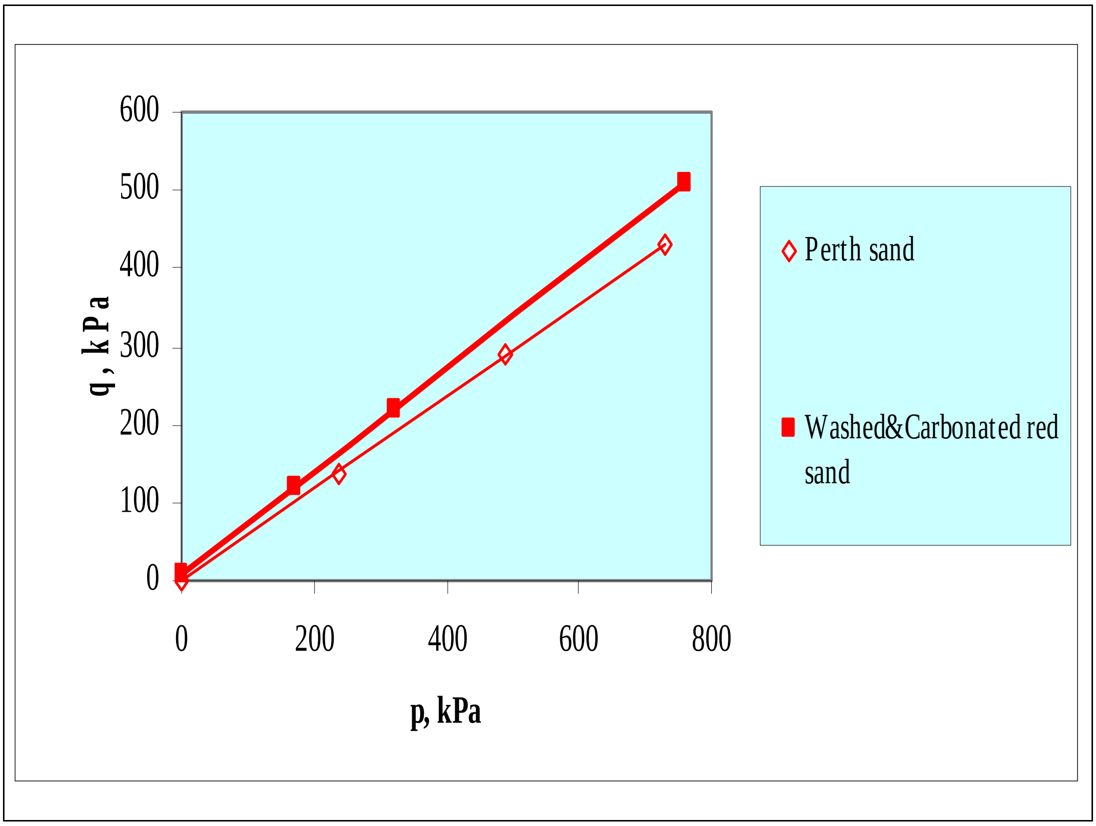


Figure 4.47 Comparison of washed and carbonated red sand and Perth sand failure envelopes

Permeability

Table 4.15 presents the coefficient of permeability, k, of washed and carbonated red sand for a seawall fill compared with its value from section 4.2.5. From these results, it was found that washed and carbonated red sand which was soaked under water for a month performs with a coefficient of permeability higher than that of the conventional method about 20 times. However, in practice, from the values reported by Lame and Whitman (1969) as in table 4.3, washed and carbonated red sand also perform as the low permeability material (10^{-5} cm/s < k < 10^{-7} cm/s).

Table 4.15 Permeability test results of washed and carbonated red sand for a seawall fill

Red sand	Coefficient of permeability, k (cm/s)	
	Modified (section 4.2.5)	**Modified (soaked under water for a month)**
Washed and carbonated	3.0 x 10^{-4}	**57.65 x 10^{-4}**

4.6 Summary

Unprocessed red sand, washed and carbonated red sand, and stabilised red sand including the reference material (HCTCRB for red sand for road bases and Perth sand for red sand characterisation and red sand for seawall fills), were extensively tested in laboratory experiments in order to evaluate the possibility of these materials as a building material for a road base, an embankment, and a seawall fill. The results obtained from this laboratory study are summarised as follow:

1) Red sand characterisation

The summarised results from characterising unprocessed red sand and washed and carbonated red sand are shown in table 4.16 and table 4.17, respectively and:

- Both red sands have a particle size characteristic very similar to Perth sand. Most fractions of both are situating within a sand range (from 2.00 mm to 0.06 mm).
- From the sieve analysis results and the gradation curve characteristics, unprocessed red sand can be grouped in the soil group SP-SM, poorly graded sand mixtures with silty soils, based on the unified soil classification system (USCS). Washed and carbonated red sand can be grouped in the soil group SP poorly graded sands following the same classification system.
- The particle shape characterisation illustrates the different features of particle appearance of red sand and Perth sand. The Perth sand is well rounded and frosted, whereas the particles of red sand formed by crushing large mineral chunks have sharp edges and corners. The surfaces are not striated, frosted, or etched.

Table 4.16 A summary of test results of unprocessed red sand

Properties	Values			
Specific gravity	3.03			
Atterberg limit	None Plasticity			
Compaction	Modified		Standard	
	MDD(t/m^3)	OMC(%)	MDD(t/m^3)	OMC(%)
	1.83	17.0	1.59	21.0
CBR	Modified		Standard	
	Soaked(%)	Unsoaked (%)	N/T***	
	55	33		
Water Conductivity	Coefficient of Permeability (cm/sec)			
	Void Ratio, e = 0.65*		Void Ratio, e = 0.89*	
	1.54×10^{-4}		6.93×10^{-4}	
Shear Strength**	Friction Angles, ø (˚)			
	Void Ratio, e = 0..65*		Void Ratio, e = 0.89*	
	At Ultimate Strength	At Peak Strength	At Ultimate Strength	At Peak Strength
	40.03	45.00	37.48	40.56

*The compacted red sand at the condition of the standard compaction test has a void ratio of 0.89 and at the condition of the modified compaction test; it has a void ratio of 0.65.
** Shear strength properties were conducted by the standard direct shear test.
*** N/T = Not tested

Table 4.17 A summary of results of washed and carbonated red sand

Properties	Values			
Specific gravity	3.08			
Atterberg limit	None Plasticity			
Compaction	Modified		Standard	
	MDD(t/m^3)	OMC(%)	MDD(t/m^3)	OMC(%)
	1.80	18.0	1.60	22.0
CBR	Modified		Standard	
	Soaked(%)	Unsoaked (%)	N/T***	
	56	50		
Water Conductivity	Coefficient of Permeability (cm/sec)			
	Void Ratio, e = 0.71*		Void Ratio, e = 0.93*	
	8.96x10^{-4}		3.0x10^{-4}	
Shear Strength**	Friction Angles, ø (˚)			
	Void Ratio, e = 0.71*		Void Ratio, e = 0.93*	
	At Ultimate Strength	At Peak Strength	At Ultimate Strength	At Peak Strength
	40.30	43.60	42.80	46.70

*The compacted red sand at the condition of the standard compaction test has a void ratio of 0.93 and at the condition of the modified compaction test; it has a void ratio of 0.71.
** Shear strength properties were conducted by the standard direct shear test.
*** N/T = Not tested

2) Red sand for road bases

- Based on the results of the compaction tests and unconfined compressive strength tests, the expected proportions of red sand, fly ash, and lime kiln dust which can perform to WA Mainroads's specifications of road base materials, are 70% of red sand: 25% of fly ash: 5% of lime kiln dust (LF ratio 1:5) and 70% of red sand: 24% of fly ash: 6% of lime kiln dust (LF ratio 1:4) for the percentage by dry weight of the mixtures.
- The shear strength parameters (c and ϕ) of stabilised red sand (the mixture of 70% of red sand: 25% of fly ash: 5% of lime kiln dust,LF ratio 1:5) are c of 161 kPa and ϕ of 41°.
- The shear strength parameters (c and ϕ) of HCTCRB are c of 155 kPa and ϕ of 47°.
- Stabilised red sand performs better in terms of cohesion (c); HCTCRB has a better friction angle (ϕ), however, Mohr-Coulomb failure envelopes in the p-q diagram of stabilised red sand and HCTCRB perform very closely.
- Stabilised red sand performs resilient modulus characteristics and permanent deformation characteristics more significantly than those of HCTCRB.

3) Red sand for embankments

- Stabilised red sand shows an effective friction angle (ϕ') at peak strength of 38° and an apparent effective cohesion (c') of 157 kPa from the consolidated drain triaxial test.
- Results of the isotropic triaxial consolidation test in form of e- $\log\sigma'_p$ curve shows the pre-consolidation stress, p_c of 120 kPa and the compression index, C_c of 0.0186.
- The coefficient of permeability of stabilised red sand is in the range 3.22 x 10^{-11} m/s to 6.34 x 10^{-10} m/s of the isotropic consolidation pressures from

50 kPa to 800 kPa. Stabilised red sand is a practically impermeable material (k less than 10^{-7} cm/s).

4) Red sand for seawall fills

- The compression index, C_c, of washed and carbonated red sand at 95% MDD and 100% OMC on the traditionally one-dimensional consolidation test is 1.08×10^{-2}.
- From the multistage consolidated drained triaxial test, the properties failure corresponds to an effective friction angle (ϕ') at peak strength of 41.34° for red sand and of 36° for Perth sand. The apparent cohesion (c) is evident only for washed and carbonated red sand of 10.78 kPa.
- Mohr-Coulomb failure envelopes in the p-q diagram of washed and carbonated red sand performs more significantly than that of Perth sand.
- Washed and carbonated red sand which was soaked under water for a month shows a coefficient of permeability higher than that of the conventional method about 20 times and also performs as low permeability material (10^{-5} cm/s < k < 10^{-7} cm/s).

CHAPTER 5

APPLICATION OF RED SAND IN ROAD BASES, EMBANKMENTS, AND SEAWALL FILLS

5.1 Overview

This chapter discusses applications of red sand and stabilised red sand as a building material for road bases, embankments, and seawall fills based on the results of the laboratory work of this study. The objective of the application of each structure is to introduce and discuss some design and construction aspects. Some construction guidelines and general comments on red sand and stabilised red sand for structures also are suggested.

5.2 The application of red sand for road bases

The technology for stabilising aggregate with lime or cement in conjunction with fly ash has been growing significantly for the last 30 years (AASHTO-AGC-ARTBA Joint Committee, 1990). In recent years, increasing road construction costs contributing to depletions of commonly used natural aggregates for roads are generating an impetus for the utilisation of by-products from industry such as fly ash, bottom ash, kiln dust, and wet-bottom boiler slag as construction materials. Available quantities of fly ash and kiln dust are increasing considerably in many areas including Western Australia. Potential by-products, from industry in Western Australia could be utilised by using Pozzolanic - Stabilised Mixture (PSM) which the main mixture obtained from Class F fly ash, a by-product from a coal power station, and activators, the by-product from the quicklime manufacturing in terms of lime kiln dust.

In this study, the PSM technique was used to stabilise to improve the properties of red sand to satisfy minimum requirements of road bases. Subsequently, the application of stabilised red sand for road bases followed a successful construction case and previous construction guidelines established for this soil stabilisation technique in conjunction with modifications of the suitability of the main mixtures used (i.e. unprocessed red sand, class F fly ash, and lime kiln dust) in this study.

5.2.1 The application and limitations of PSM

PSM may be used as either a base or subbase. A wearing surface is required for the PSM layer such as a seal coat for low volume roads and asphaltic concrete for high volume roads in a flexible pavement system. A good long-term performance of PSM roads strongly depends on good mixture selection and sound construction techniques. For road durability, it depends on the PSM constituents. High relative density is critical for high strength and durability. For any joints, they have to be cut to control wandering reflective cracking, and they might be appropriately sealed to prevent the intrusion of water. Above all, this technique has to take into consideration the season of construction to gain the strength development characteristics of the mix in respect to degree-days- 40° F. base (AASHTO-AGC-ARTBA Joint Committee, 1990) .

5.2.2 Mix design and specification requirements of stabilised red sand for road bases

- *Mix design*

The stabilisation of red sand for road bases with fly ash and lime kiln dust was trialled using the general PSM technique which has a long and successful history. This application, termed Pozzolanic-Stabilized Mixture (PSM), uses three main materials in this study to construct stabilised red sand bases. Class F fly ash was used by blended with lime kiln dust (LKD) to be the additional mixture of unprocessed red sand. Typical proportions for Class F fly ash and LKD blends are 10 to 50 % class F fly ash (higher than amounts which had been mixed with other aggregate because red sand is rather fine compared to commonly used aggregates) and the LF ratios are 1:1 to 1:5 based on the particular experimental results and sources and quality of additional mixtures (fly ash and lime kiln dust).

*Strength***-** Closely controlled curing conditions are important as both time and temperature significantly affect strength. Using standard proctor-sized specimens; the normal curing for the LKD, fly ash, and red sand mixtures is at +38°C (100 °F) for 7 days.

The following steps summarise the procedures for a laboratory determination of mix proportions:

- Obtain a representative sample of red sand. Determine the particle size distribution.

- Use 115 mm in height and 105mm in diameter moulds for all test samples. Add fly ash to the aggregate in five different proportions, starting at the lower limit and proceed in convenient increments to the upper limit. Carry out compaction procedures at estimated optimum moisture content.

- Determine the moulded dry density of each red sand-fly ash blend. Plot the test results to identify a peak value or maximum dry density.

- Select optimum matrix content at least two percent above the matrix content found at the maximum dry density. Then determine the optimum moisture content and maximum dry density for that blend.

- Determine the most suitable proportions of activator to fly ash. Use five different activator-to-fly ash combinations at the optimum matrix content. The five combinations should span the recommended range of ratios for each activator.

- Prepare three proctor-size specimens for each combination in accordance with the compaction procedures in AS 1289.5.2.1. Cure all three test specimens for seven days in sealed containers. For lime or kiln dust activators, cure at 38 degrees C (100 degrees F).

- Test three specimens for compressive strength at the end of the seven-day curing period.

- Plot a curve of compressive strength as a function of activator percentage for each of the five activator-to-fly ash combinations. Only test mixtures with a seven-day compressive strength in the range of 0.6 MPa to 1.0 MPa as a potential PSM for field use following WA Mainroads' specification.

- Select the most economical (lowest percentage activator) mixture that exceeds the compressive strength and durability requirements. The PSM actually used in the field should contain a higher percentage of activator.

5.2.3 Construction instructions of stabilised red sand for road bases

These construction instructions was adopted from Fly Ash Facts for Highway Engineers Chapter 4 - Fly Ash in Stabilized Base Course (Federal Highway Administration, 2006)

- *Blending of materials*

Central plant mixing provides the best quality, although in-place mixing has also been successful. Most plants use a continuous pugmill, but central mix concrete plants could work well. When unconditioned (dry) fly ash is used, silo and surge bins are needed for LKD and fly ash. While belt feeding, drop dry fly ash on top of the aggregate to keep it from rolling down the belt during pugmill loading. Conditioned Class F fly ash can be routinely added through an aggregate.

- *In-place mixing*

In-place mixing involves the use of portable pulverizing and mixing equipment to blend granular soil or aggregate materials with PSM reagent material and water in pre-determined proportions at the project site. Class F fly ash is usually added in conditioned form, although it may also be added dry. The reagent materials (lime kiln dust, LKD) would be added after the fly ash and are most often introduced in a dry form, although they may be added in a slurry form in order to minimize dusting. Water is usually sprayed on the mixture as needed just prior to in-place mixing.

- *Spreading*

A PSM can be placed with spreader boxes or asphalt laydown machines. Equipment with automated grade control is highly recommended. Layers are normally spread to a thickness of 15 to 30 percent greater than the desired compacted thickness. Maximum lift thickness is 200 to 250 mm (8 to 10 in). Place the second lift on the same day or take appropriate measures to ensure adequate sealing and subsequent bonding of additional lifts.

- *Compaction*

Achieving a high degree of compaction is crucial to the successful performance of PSM road bases. Final density should be reached as quickly as possible to achieve the highest ultimate strengths. Compacting this cohesionless material (like red sand), with steel-wheel pneumatic and vibratory rollers has been successful. The PSM surface should be kept moist throughout compaction and PSM moisture should be on the low side of optimum to achieve the best field compaction. If placed with a spreader box, the final surface should be fine graded with a motor grader before final rolling with a steel-wheeled roller. When fine grading, take care not to fill in the low spots because the feathering-in will tend to reduce bonding at that location, thus creating a potential trouble spot. If equipment with graded control is used, fine grading is not required.

- *Curing*

Compacted layers should be quickly sealed to prevent drying. Apply a prime coat of 0.45 to 0.90 litters per square meter of cut back or emulsified asphalt to the moist surface within 24 hours of final compaction. Multiple applications of lighter coats tend to produce better penetration and improve adhesion.

5.2.4 General pavement design on stabilised red sand for road bases

Based on the experimental results of the stabilised red sand for road bases, the objective of general pavement design on stabilised red sand for road bases are:

- to suggest the appropriate resilient modulus range of stabilised red sand for pavement-mechanistic design,
- to introduce the suitable depth of stabilised red sand as a base layer of Western Australia roads, and
- to estimate the traffic loading intensity of the stabilised red sand-base course road.

For the road empirical design procedure, base course materials are characterised in terms of their California Bearing Ratio (CBR). The required CBR is controlled by the depth of the material below the wearing surface and is specified in the design chart. When the mechanistic design procedure becomes important and is to be widely used, base course materials are characterised by their modulus (elastic or resilient modulus). It is generally recognised that the modulus of unbound granular materials (i.e. crushed rock, crushed limestone) is stress dependent. For the stabilised red sand, its modulus test result is stress dependent as well (from the test results). It was found that the stress dependency of vertical modulus can be modelled by using the elastic model CIRCLY (MINCAD Systems, 2004) by dividing the granular layers into several sub-layers. However, the horizontal component of stress dependency cannot be directly modelled using CIRCLY. For this reason, this study used the MICHPAVE finite element program (Harichandran, Yeh, & Baladi, 1990) which considers the non-linear behaviour and stress dependent of pavement materials to analyse the vertical stress and the horizontal stress acting on the stabilised red sand base layer.

To achieve all the objectives of red sand for road bases, the procedures are performed as in figure 5.1. From the mechanistic design step, the pavement structure scenario was established first from the generally used pavement cross-section in Western Australia which contains asphalt as a road surface, HCTCRB as a road base, crushed limestone as a road subbase, and Perth silty sand as a road subgrade. For the base layer, the commonly used material, HCTCRB, was replaced with the stabilised red sand. Figure 5.2 shows the pavement scenario including the important parameters and the resilient modulus models of each pavement layer. The pavement was analysed to find the vertical stress and the horizontal stress occurring in the stabilised red sand base layer by using the MICHPAVE finite element program (Harichandran et al., 1990). The suitable resilient modulus of the stabilised red sand for mechanistic design was determined from its resilient modulus model with relying on the laboratory results of resilient modulus tests. The CIRCLY 5.0 was used for mechanistic pavement design to determine the traffic loading intensity of the stabilised red sand base course road.

Table 5.1 shows the stress analysis results from the MICHPAVE finite element program. These results were determined by simulating that the Equivalent Standard Axial (ESA) performs on the pavement and were the values at the top and the bottom of the stabilised red sand layer varying in depth from 150 mm to 350 mm. The results show that the occurring stress in terms of the bulk stress ($\sigma_{b)}$ caused from ESA (80 kN) is in the range of 430 kPa to 700 kPa.

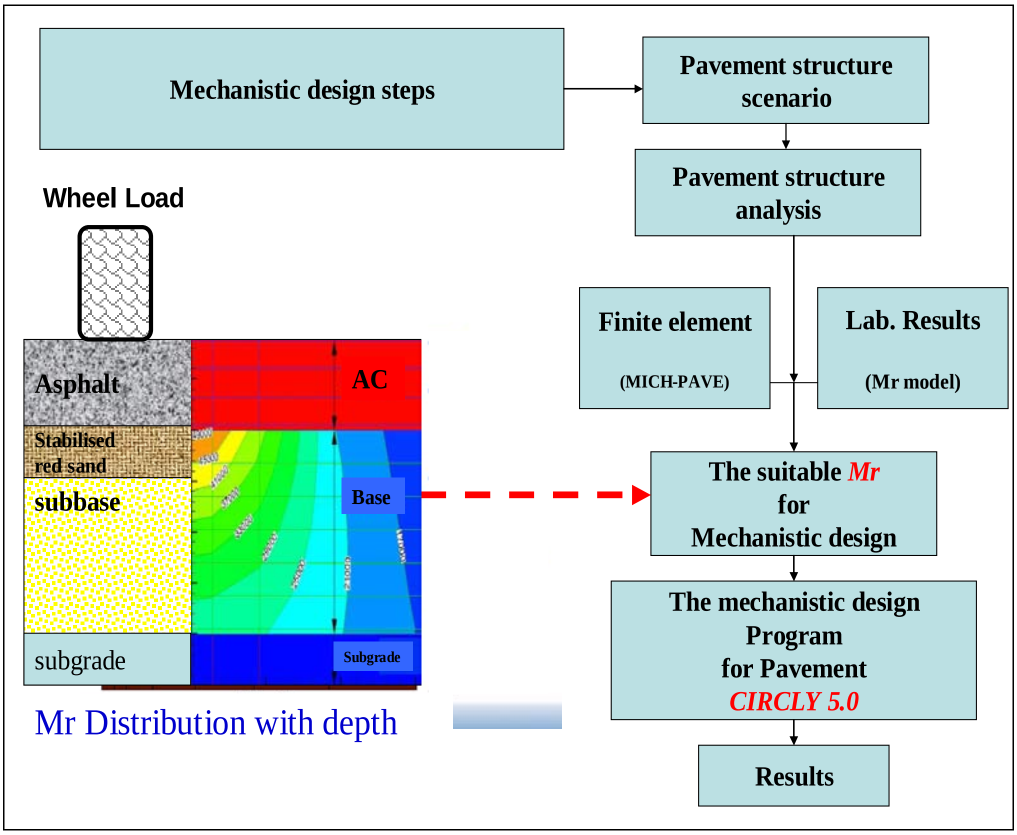


Figure 5.1 Pavement design diagram for stabilised red sand as a base layer

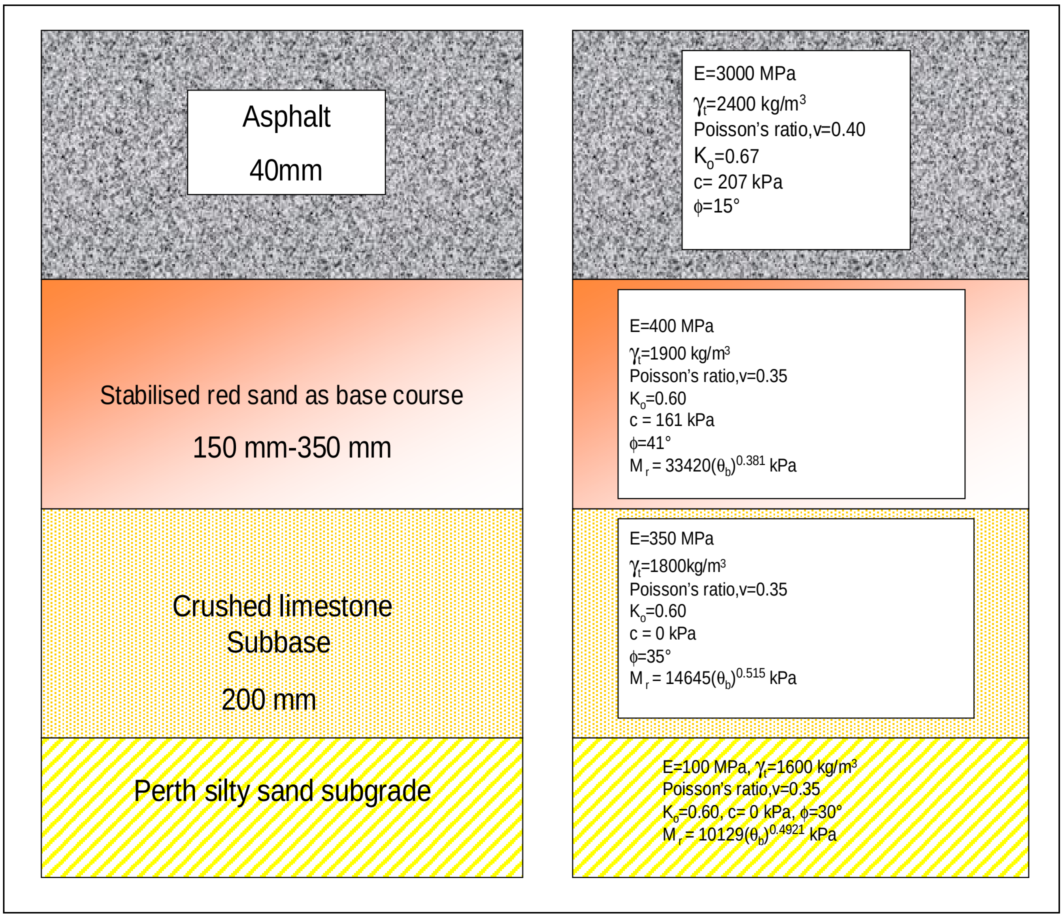


Figure 5.2 The pavement scenario in this study

Table 5.1 Stress results from the MICHPAVE finite element program

Locations on The stabilised red sand layer	Vertical stresses σ_1 kPa	Horizontal stresses σ_3 kPa	Bulk stresses, $\sigma_b=\sigma_1+2\sigma_3$ kPa
Top	600	50	700
Bottom	400	15	430

Figure 5.3 indicates that governed by the resilient modulus model of stabilised red sand as equation 5.1 which was from laboratory results and the K-Theta model in section 4.3.3, the resilient modulus values with respect to the bulk stress of 430 kPa to 700 kPa are in the range of 335 MPa to 410 MPa. These values could be the suggested value of the resilient modulus of stabilised red sand for mechanistic pavement design.

$$Mr = 33.427(\sigma_b)^{0.381} \tag{5.1}$$

Where:

Mr = resilient modulus, MPa

σ_b = bulk stress = $\sigma_1 + 2\sigma_3$, kPa

Table 5.2 shows a summary of the pavement configuration analysed in CIRCLY 5.0. Figure 5.4 illustrates the results from CIRCLY 5.0 in terms of the graph of the traffic loading intensity plotted against the varied depth of the stabilised red sand. CIRCLY 5.0 is capable of conducting parametric analysis with one independent parameter of the stabilised red sand depth from 150 mm to 350 mm. This figure indicates that more than 150 mm of the stabilised red sand depth could resist a traffic load higher than the design (1.0 x 10^6 ESA). The load intensity increases dramatically while the depth increase from 150 mm to 200 mm and it tends to be constant in 200 mm to 350 mm depth range. From these results, it could be suggested that the appropriate depth of the stabilised red sand as a base layer is 200 mm to 300 mm.

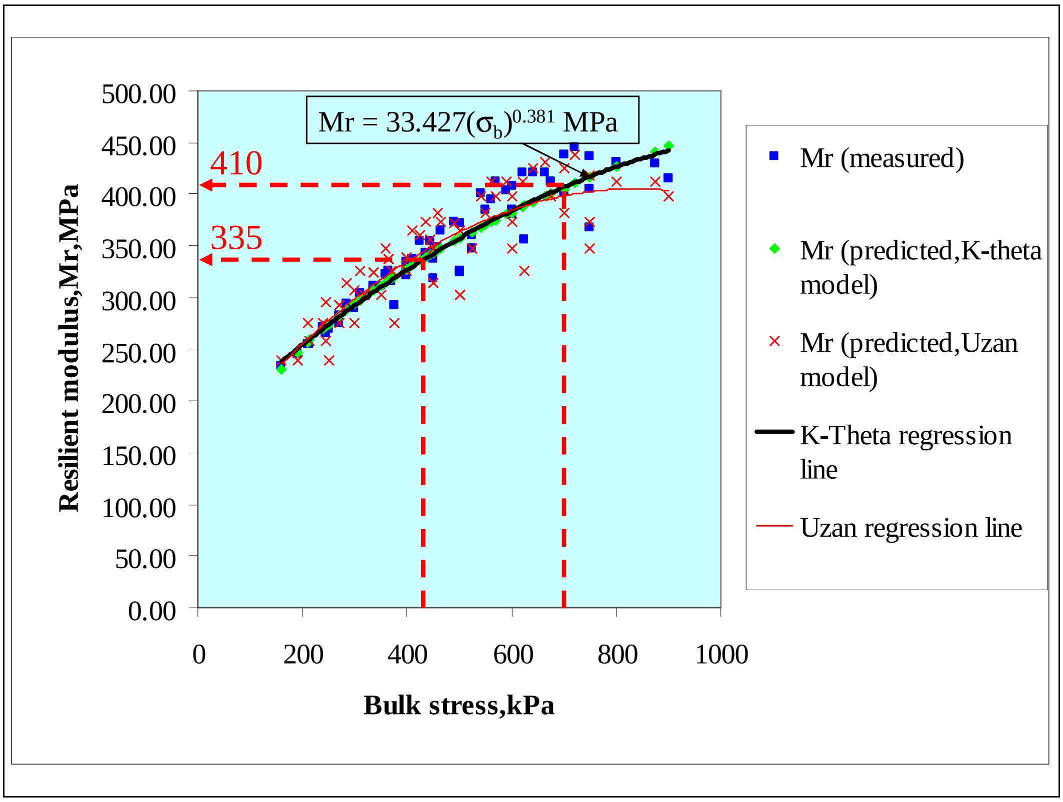


Figure 5.3 Resilient modulus model and resilient modulus of stabilised red sand

Table 5.2 Pavement configurations used in CIRCLY analysis

Stabilised red sand pavement		Design traffic load = 1.0 x 10^6 ESA		
Layer No.	Material ID	Isotropy	Modulus (MPa)	Layer thickness (mm)
1	Asphalt	Isotropic	3000	40
2	Stabilised red sand	Isotropic	400	150-350
3	Unbound granular crushed limestone	Anisotropic	350	200
4	Subgrade CBR 15	Anisotropic	150	Infinite

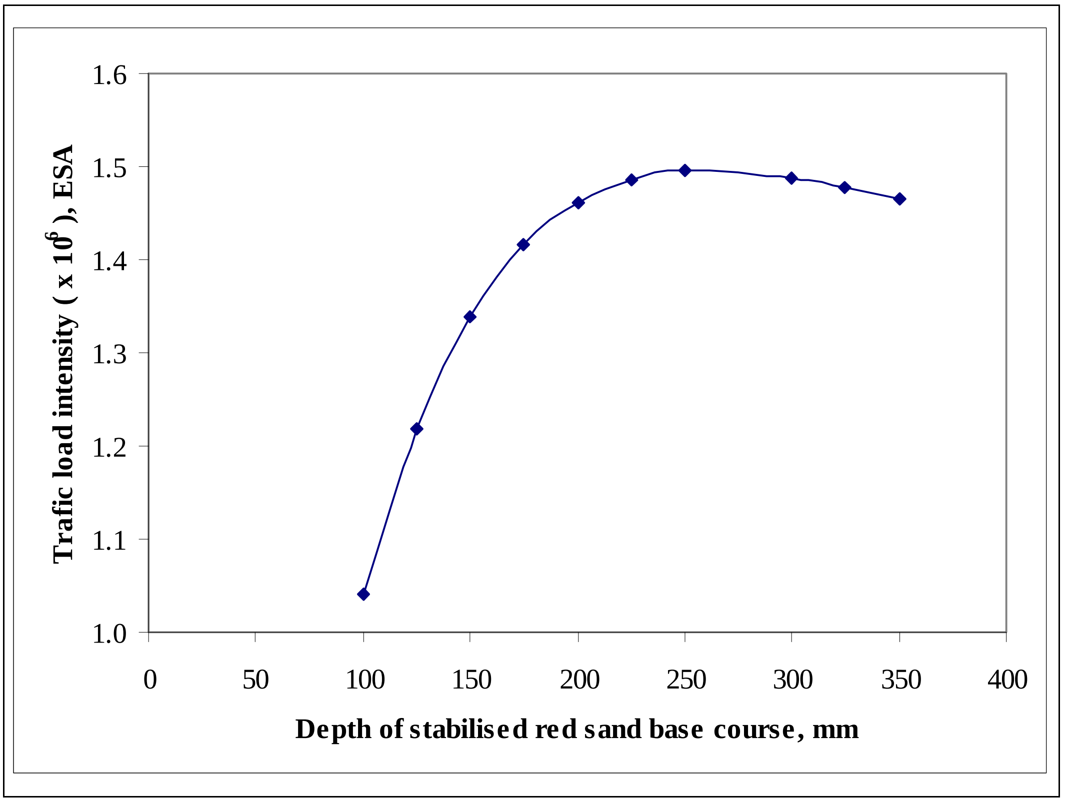


Figure 5.4 CIRCLY analysis results

Referring to the objective of general pavement design on stabilised red sand for road bases, it could be suggested that;

1. The appropriate resilient modulus is 335 kPa to 410 kPa.
2. The suitable depth of stabilised red sand as a base layer for WA roads is 200 mm to 300 mm.
3. The traffic load intensity of the stabilised red sand-base course road is about 1 x 10^6 ESA.

5.3 The application of red sand for embankments

Embankment materials usually used in construction are generally characterised on the basis of soil type, grain size distribution, shear strength, compaction, and permeability. In this research, an attempt has been made to create stabilised red sand for use as an embankment material. Compaction, permeability, consolidation, and strength behaviour of stabilised red sand were investigated by a series of tests conducted and application of stabilised red sand for embankment construction was also evaluated based on the laboratory results.

This section discusses the application of stabilised red sand as a building material for highway embankments based upon experiments. Two aspects of interest are discussed for highway embankment applications of such material, design and construction. Due to stabilised red sand coming from three main substances (unprocessed red sand, fly ash, and lime kiln dust) which are by-products from industry, they are not acommercial product which must be produced to be free from environmental impacts. These impacts must concern for stabilised red sand embankment construction because a stabilised red sand embankment has not been constructed yet and environmental impacts could be prevented by using a successful construction case history of a by-product utilisation project for embankments which have environmental concerns. This issue is included in the design and construction aspects which are presented in this section.

5.3.1 Design aspects

All three main materials of red sand stabilisation are collected from disposal areas in a particular industry. There are many factors which affect the quality of these materials such as sources, processes, and the surrounding areas. These factors are not typically constant from site to site. Due to the inherent variation in main materials, laboratory evaluation is needed during design process. The selection of design parameters must be based on laboratory test results of representative material samples in particular materials' sources and construction sites.

From the overall stability of embankment point of view, a highway embankment material has to meet two basic requirements: sufficient strength (can support safely its own weight and any applied load acted on) and small settlement (can provide a long term of appropriate serviceability). Consequently, for this embankment design, slope stability and settlement analyses need to be performed to evaluate of these requirements have been satisfied. Laboratory tests of stabilised red sand for embankments in this study indicated that shear strength and compression characteristics of stabilised red sand behave very closely to those of cohesive granular materials (c and ϕ materials). For this reason, it should be indicated that analyses of stabilised red sand embankments (i.e. slope stability and settlement calculations) should be carried out by using fundamental methods as usually used for those of cohesive granular materials.

For the environmental impacts of this embankment construction, the embankment design must be governed by minimizing environmental problems. The primary environmental concern is contamination of ground and surface water around embankment areas from leaching. This problem could be minimised by controlling the amount of water which infiltrates or run onto the embankment. This can be accomplished by diverting the water around the embankment. For the running water onto the embankment surface, it can be managed by the good surface water collection system. In the case of water can be moved out from the embankment surface well enough, the pavement on top of the embankment can be the water barrier of infiltration from the top. To restrict infiltration through side embankment slope, the embankment may be encased inside a liner system (i.e. a low permeability soil and impermeable geosynthetics) while a proper drainage and leachate collection system is provided. Preventing intrusion of groundwater is also essential. A drainage blanket of properly sized granular materials may be placed in the bottom layer of stabilised red sand embankment to move out the water away from the embankment. Figure 5.5 shows the proposed stabilised red sand embankment.

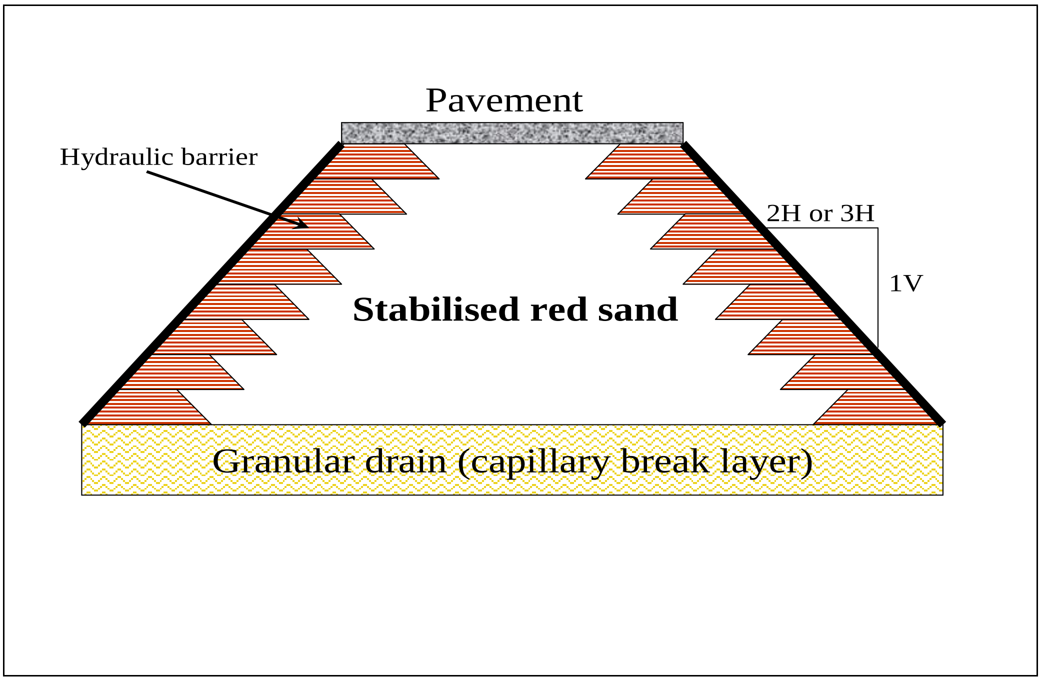


Figure 5.5 Proposed stabilised red sand embankment

5.3.2 Construction aspects

Construction using stabilised red sand could follow the same conventionally accepted landfill practices as conventional construction contributing to landfill construction techniques for environmental purposes and pozzolanic soil stabilisation techniques for soil stabilisation purposes.

Stockpiling- red sand and additional mixtures could be stockpiled in a climate-controlled environment separately. Each mixture stored under controlled climatic conditions can be delivered under a narrow limitation on moisture content.

Site preparation- the site could be prepared for stabilised red sand placement in the same way as prepared for general soil fill materials. It should be cleared and grubbed, and the topsoil should be retained for final cover. The drainage system for preventing groundwater capillary rise must be performed.

Mixing- the constituents of the mix may be accurately proportion, thoroughly mixed in a mechanical mixer.

Placing- the mixture should be placed on a suitably prepared layer (can provide sufficient strength and stiffness) and the mix should be placed and compacted the day it is mixed.

Compacting –compaction of the mixture should begin as soon as possible after placement and the addition of water continued until the specified density has been obtained.

Curing- After compating, they must be protected against drying by maintaining the surface in a moist condition.

5.4 Application of red sand for seawall fills

Generally, a seawall is a barrier, usually vertical walls, between the land and water that protect from wave erosion. A seawall is a massive structure that is designed primarily to resist wave action along high value coastal property. Seawalls may be either gravity- or pile-supported structures. Common construction materials are either concrete or stone. Seawalls can have a variety of face shapes. Concrete seawalls are often pile-supported with sheetpile- cutoff walls at the toe to prevent undermining. Additional rock toe protection may also be used. The seaward face may be stepped, vertical, or re-curved. Rubble-mound seawalls are designed like breakwaters using a rock size that will be stable against the design wave.

Although there is a wide range of seawall structures, this study focused on only a retaining structure seawall and a rubber-mound seawall. For the application of red sand for seawall fills in this section, washed and carbonated red sand which is supposed to be the fill material of both seawall structures is discussed in terms of some design aspects and general comments of using washed and carbonated red sand as a seawall fill material.

5.4.1 A seawall retaining wall

A seawall retaining wall or a bulkhead is used as a retainer, providing protection and stabilising the land that it supports. Bulkheads are retaining walls whose primary purpose is to hold or prevent the backfill from sliding while providing protection against light-to-moderate wave action. They are used to protect eroding bluffs by retaining soil at the toe, thereby increasing stability, or by protecting the toe from erosion and undercutting. They are also used for reclamation projects, where a fill is needed seaward of the existing shore and for marinas and other structures where deep water is needed directly at the shore. Bulkheads are either cantilevered or anchored sheetpiling or gravity structures such as rock-filled timber cribbing. Figure 5.6 illustrates an example of a seawall retaining wall.

Figure 5.6 A typical seawall retaining wall (Blankenship, 2003)

Regarding the possibility of using washed and carbonated red sand as the backfill material of such a structure, relevant issues have to be considered because the overall stability of a seawall retaining structure invloves many factors.

Design aspects

The design consideration of a seawall retaining wall is different from a conventional retaining wall in terms of the dynamic load from sea waves but its fundamental design is similar.

Generally, in the design of free-standing retaining walls, the following aspects need to be investigated:

- the stability of soil around the wall;
- the stability of the retaining wall itself;
- the structural strength of the wall;
- damage to adjacent structures due to wall construction.

From the stability concerns mentioned above, washed and carbonated red sand as a backfill material involves the magnitude of the earth's pressure (is generally generated from the weight of backfill material) which will be exerted on a wall is dependent on the amount of movement that the wall undergoes.

It is usual to assume for free-standing retaining walls that sufficient outward movement occurs to allow active (minimum) earth pressures to develop. The designer must ensure that sufficient movement can take place without affecting the serviceability or appearance of the wall. Moreover, the coefficient of lateral earth pressure (K) is strongly dependent on the movement characteristic of the wall, in particular adding the dynamic load effect to this. Therefore, the condition and types of backfill materials also influence the K-parameter. Washed and carbonated red sand should be investigated regarding its effects on the K-parameter.

Other considerations

Other design cases, or variations of the one above, which involves a construction sequence or the future development of surrounding areas should also be considered. For instance, additional surcharges may be needed and allowances made for any possible future removal of ground in front of the wall in connection with services, particularly if the passive resistance of this material is included in the stability calculations. The effect of excavation on the wall bearing capacity may also need to be considered.

For the determination of earth pressure, it is usual to consider a unit length of the cross-section of the wall and retained soil. A unit length is also used in the structural design of cantilever walls and other walls with a uniform cross-section.

Washed and carbonated red sand, a free draining granular material of high shearing strength can be an ideal backfill for a minimum section wall, however, the final choice of material should be based on the cost and availability of materials against the cost of more expensive walls.

General comments of washed and carbonated red sand as a seawall retaining wall backfill material

- The selection of design parameters must be based on the effective parameters (used $\phi' = 40°$) due to the backfill (red sand) behind and soil beneath a seawall are saturated with a relatively high water table.
- The seawall must be designed by considering the effect of dynamic loads from sea wave motion. This is different from a general retaining structure.

- Liquefaction phenomenon of the backfill material (washed and carbonated red sand) has to be evaluated.
- The seawall retaining wall has to resist lateral force from the pressure of a back fill material (see figure 5.7)
- The lateral fore strongly depends on the K-coefficient of lateral earth pressure which K~1/f(ϕ′)
- Red sand seems to be *more stable backfill* material than Perth sand because ϕ′(red sand) > ϕ′(Perth sand)

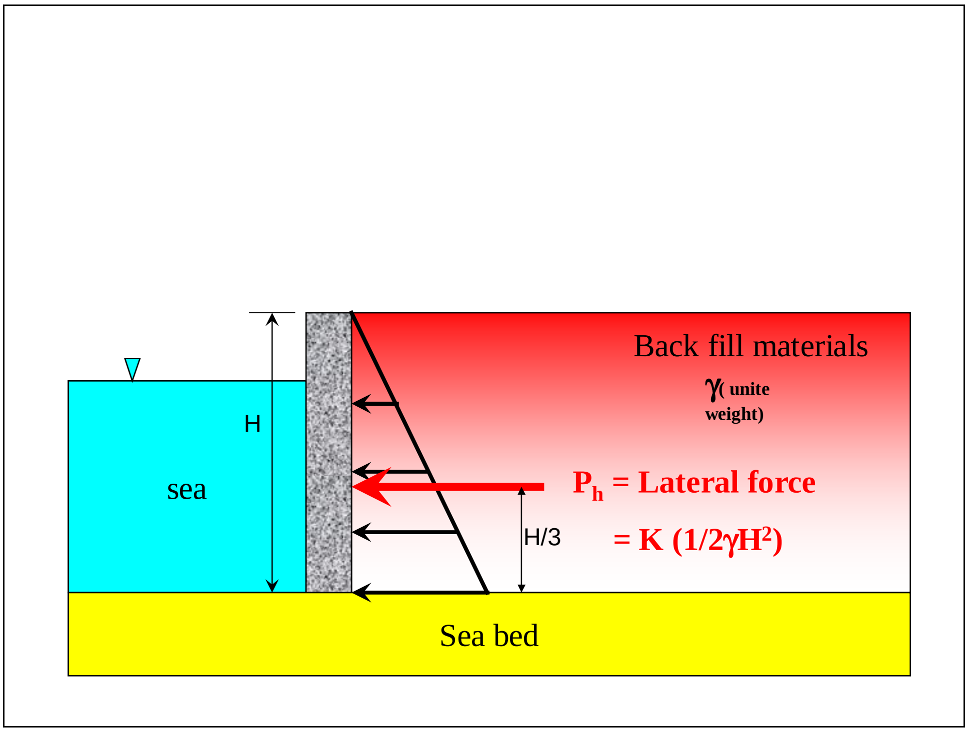


Figure 5.7 Lateral force acting on a seawall retaining wall

5.4.2 A rubble-mound seawall

A rubble-mound structure tends to be the usual seawall structure in Western Australia. It generally consists of at least three main parts: a core of small stone or coarse aggregate, usually using " run-of-quarry"; an armour layer of large stones or specially-shaped concrete units; and one or more intermediate layers as " underlayers" which separate the core from the amour as shown in figure 5.8.

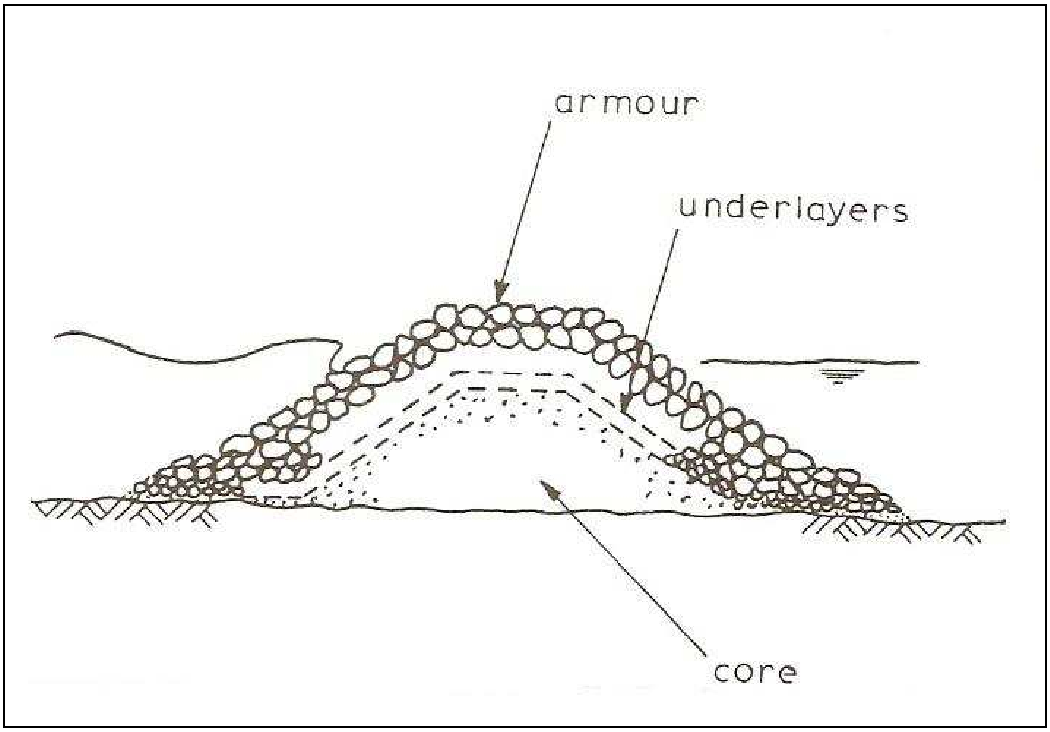


Figure 5.8 Typical cross-section of a rubble-mound structure (Hedges, 1983)

Using washed and carbonated red sand as rubble-mound seawall materials could be a core material because this layer does not need to use large size materials.

However, not only the main material on an armour layer need large size materials for a rubble-mound structure stability but also the core layer as it has a number of very important functions to perform. The demands on the core are that (Hedges, 1983);

- it should form a satisfactory foundation for the underlayers and armour, and for any wave wall which may be required;

- it should provide a relatively impermeable barrier to the transmission of wave energy;

- it should form a suitable working platform from which underlayers, armour, and wave wall my be constructed; and

- it should constitute a substantial portion of the total volume of the structure since it is composed of material which is relatively cheap in comparison with underlayers and armour.

To meet the core material demands mentioned above washed and carbonated red sand would have a significant capability to provide them. However, as it is only the alternative material and a rubble-mound seawall with a red sand core has not yet been constructed, there are a number of interesting points concerning design and construction that need to be considered.

The effect of a core material permeability on overall stability

The coefficient of permeability of a soil is the rate of flow of water per unit area of soil when there is a unit hydraulic gradient and its value depends primarily on the average size of the soil pore. In general, the finer soil particles, the smaller the pore and the lower the permeability. Permeability has a pronounced effect on the transmission of wave energy through the structure and there will be some influence on wave run-up and run-down on the face of the mound which may affect armour stability. For the permeability of core materials, the influence of the core shows a decrease in stability as the permeability is reduced. Consequently, in addition to influencing the stability of the armour, the characteristics of the core material are of primary significance to the overall stability of the rubble mound. The desired core material is a densely packed but fairly permeable material. When considering the property of red sand, it was found that washed and carbonated red sand at modified density has a low permeability from the results of this study. A process to make washed and carbonated red sand meet this requirement must be provided so blending a coarser material may be employed to make the washed and carbonated red sand becomes a fairly permeable core material.

A core material as filters

Many failures of rubble-mound structures have been attributed to internal erosion. Consequently, when washed and carbonated red sand is used; the underlayer must be designed to act as a filter to prevent it from being washed out of the structure. The grading of the underlayers usually depends on the grain size distribution of washed and carbonated red sand (a core material) and on the maximum size of voids in the armour layer. Washed and carbonated red sand as a core material for a breakwater seawall has to prevent leaching out by using coarse materials which have the proper size placed on top ($\frac{D_{top}}{d_{redsand}} \leq 20$). In the case of the suitable underlayers for washed and carbonated red sand not able to be sourced, the protect system of leaching of red sand has to be provided.

CHAPTER 6

CONCLUSIONS AND RECOMMENDATIONS

6.1 Conclusions

This study aimed to evaluate the suitability of red sands (unprocessed red sand and washed and carbonated red sand) as substitutes for conventional materials in road bases, highway embankments, and seawall fills. Representative, large samples of unprocessed red sand and washed and carbonated red sand, collected from Alcoa's Kwinana refinery in Western Australia, were extensively studied in the laboratory for the physical and geotechnical engineering evaluation of both red sands and stabilised red sand. Based upon the properties of these materials found in the laboratory, application to the structures was evaluated and some construction guidelines and design and construction aspects were introduced. The following conclusions are drawn from this study.

6.1.1 Red sand characterisation

The findings of the red sand characterization are:

1) Particle size analysis demonstrates that most red sand fractions lie within the known sand fractions. Unprocessed red sand can be grouped in the soil group SP-SM, a poorly graded sand mixture with silty soils, based on unified soil classification system (USCS) and washed and carbonated red sand is in SP, a poorly graded sand. The observation of microscopy

pictures of unprocessed red sand and Perth sand found that the natural sand is well rounded and frosted. While the particles of red sand formed by crushing mineral ore (bauxite) have sharp edges and corners. The surfaces are not striated, frosted, or etched.

2) The particle size distribution and gradation charts of both red sands lie in the boundary of earthwork materials following WA Mainroads' specifications. This means red sand could be earthwork material. However, both red sands lie out of subbase and base material ranges of WA Mainroads' specifications. Hence, both red sands by themselves could not be subbase or base material without stabilisation.

3) From the compaction test results, the maximum dry densities (unit weight) are 1.83 tons/m^3 of unprocessed red sand and 1.80 tons/m^3 of washed and carbonated red sand. The modified optimum moisture contents are 17 % of unprocessed red sand and 18 % of washed and carbonated red sand. For the standard compaction test on red sands, the maximum dry densities (unit weight) are 1.59 tons/m^3 of unprocessed red sand and 1.61 tons/m^3 of washed and carbonated red sand. The standard optimum moisture contents are 21% of unprocessed red sand and 22% of washed and carbonated red sand. The effect of compaction effort still exists on red sand for more compaction effort (modified compaction) on it makes maximum dry density increase decreasing their optimum moisture content when compared to less compaction effort (standard compaction).

4) The particle size distribution characteristics of red sands are like Perth sand but the compaction characteristics of both red sands are quite different from cohesionless soils (sands). Perth sand as a cohesionless soil

does not respond to variation in compacting moisture content and compactive effort in the manner characteristic of fine-grained soils such as clay. The typical compaction curve for cohesionless soils is the low density that is obtained at low water content is due to capillary forces resisting rearrangements of the sand grains.

5) The specific gravity of the unprocessed red sand of 3.03 and the washed and carbonated red sand of 3.08 are similar. Although the washed and carbonated red sand contains more coarse particles, the mineral compositions for both types of red sand are the same hence the specific gravity would be identical. When comparing the specific gravity of red sands with that of Perth sand (Gs=2.62), it was found that even if red sands are likely to be cohesionless soil obviously, their specific gravity is much higher than a general cohesionless soil as Perth sand.

6) The permeability test results of red sands, unprocessed red and washed and carbonated red sand, in terms of the coefficient of permeability, k are from 8.69×10^{-4} to 1.54×10^{-4} cm/s, based on the methods of compacting samples (the modified compaction and the standard compaction)from sample preparation processes. The results of both red sand types could be grouped in low degrees of permeability which have coefficient of permeability between $10^{-3} – 10^{-5}$ cm/s (Terzaghi & Peck, 1967).

7) CBR results of both types of red sands are for soaked CBR, 55 % of unprocessed red sand and 56% of washed and carbonated red sand and for un-soaked CBR, 33% and 50% of unprocessed red sand and washed and carbonated red sand, respectively. Both red sand types cannot comply with the specifications for road base materials (Austroads, 2004).

8) The shear strength parameter,ϕ, from direct shear tests on both types of red sands at standard compaction density and modified compaction density indicates that ϕ values are in between 37.48° and 46.7° and washed and carbonated red sand shows higher friction angles of both ultimate and peak friction angles than unprocessed red sand. Both types of red sands attain very good strength parameters.

6.1.2 Red sand for road bases

The findings of red sand for road bases are:

1) Based on the results of the compaction tests and the unconfined compressive strength tests, the expected proportions of red sand, fly ash, and lime kiln dust ,which can perform as WA mainroads's specifications of road base materials, are 70% of red sand: 25% of fly ash: 5% of lime kiln dust (LF ratio 1:5) and 70% of red sand: 24% of fly ash: 6% of lime kiln dust (LF ratio 1:4) for the percentage by dry weight of the mixtures.

2) The shear strength parameters (c and ϕ) of stabilised red sand (the mixture of 70% of red sand: 25% of fly ash: 5% of lime kiln dust, LF ratio 1:5) are c of 161 kPa and ϕ of 41°.

3) The shear strength parameters (c and ϕ) of HCTCRB are c of 155 kPa and ϕ of 47°.Stabilised red sand performs better in terms of cohesion (c); HCTCRB performs the better friction angle (ϕ), however, Mohr-Coulomb failure envelopes in the p-q diagram of stabilised red sand and HCTCRB

behave very closely. Stabilised red sand performs resilient modulus characteristics and permanent deformation characteristics more significantly than those of HCTCRB.

4) The general pavement design of stabilised red sand for road bases is based on the resilient modulus model derived from the laboratory results from this study. The presumptive values of road material properties, and the pavement analysis on CIRCLY 5.0 pavement design program are 1) the appropriate resilient modulus; 335 kPa to 410 kPa, 2) the suitable depth of stabilised red sand as a base layer for WA roads; 200 mm to 300 mm, and 3) the traffic load intensity of the stabilised red sand-base course road; about 1 x 10^6 ESA.

6.1.3 Red sand for embankments

The findings of red sand for embankments are:

1) Stabilised red sand shows an effective friction angle (ϕ') at peak strength of 38° and apparent effective cohesion (c') of 157 kPa from the consolidated drain triaxial test.
2) Results of the isotropic triaxial consolidation test in form of e- logσ'_p curve shows the pre-consolidation stress, p_c of 120 kPa and the compression index, C_c of 0.0186.

3) The coefficient of permeability of stabilised red sand is in the range from 3.22 x 10^{-11} m/s to 6.34 x 10^{-10} m/s of the isotropic consolidation pressures

from 50 kPa to 800 kPa. Stabilised red sand is the practical impermeable material (k less than 10^{-7} cm/s).

4) From the design aspect of stabilised red sand for embankments, due to the inherent variations in main materials, laboratory evaluation is needed during the design process. The selection of design parameters must be based on laboratory test results of representative material samples in particular materials' sources and construction sites.

5) For embankment design, slope stability and settlement analyses need to be performed to evaluate if requirements are met. Laboratory tests of stabilised red sand for embankments in this study indicated that analyses (i.e. slope stability and settlement calculations) may be carried out using fundamental methods usually used of cohesive granular materials.

6) For the environmental impacts of embankment construction, the contamination of ground and surface water around embankment areas from leaching has to be a concerned. The embankment may be encased inside a liner system (i.e. a low permeability soil and impermeable geosynthetics) while a proper drainage and leachate collection system is required to restrict infiltration through side embankment slopes. Preventing intrusion of groundwater is also essential. A drainage blanket of properly sized granular materials may be placed in the bottom layer of a stabilised red sand embankment to move the water away from the embankment.

6.1.4 Red sand for seawall fills

The findings of red sand for seawall fills are:

1) The compression in index, C_c, of washed and carbonated red sand at 95%MDD and 100%OMC on the traditionally one-dimensional consolidation test is 1.08 x 10^{-2}.

2) The properties failure correspond to an effective friction angle (ϕ') at peak strength of 41.34° for red sand and of 36° for Perth sand. The apparent cohesion (c) is evident only washed and carbonated red sand of 10.78 kPa from the multistage consolidated drained triaxial test.

3) Mohr-Coulomb failure envelopes in the p-q diagram of washed and carbonated red sand perform more significantly than Perth sand. Washed and carbonated red sand which was soaked under water for a month performs with a coefficient of permeability higher than that of the conventional method about 20 times and also acts as a low permeability material (10^{-5} cm/s < k < 10^{-7} cm/s).

4) General comments of washed and carbonated red sand as a seawall retaining wall backfill material are the selection of design parameters must be based on effective parameters (used $'\phi = 40°$). A red sand seawall must be designed by considering the effect of dynamic loads from sea wave motion. This is different from a general retaining structure. Washed and carbonated red sand) has to be evaluated a liquefaction resistance. Red

sand seems to be a *more stable backfill* material than Perth sand because ϕ'(red sand) > ϕ'(Perth sand).

Based on the results of this study, it appears that red sand and stabilised red sand are suitable for use in road bases (stabilised red sand), highway embankments (stabilised red sand), and seawall fill (washed and carbonated red sand), if proper design and construction procedure are followed.

6.2 Recommendation for future study

1) Laboratory investigations in this study have indicated that red sand and stabilised red sand appear to be suitable for use in the construction of road etc. It is recommended that these materials none be available under actual service conditions. Further research needs to focus on the correlation of the laboratory results to field performance.

2) For the stabilised red sand for road bases, further investigation into exact failure modes is recommended because the actual behaviour of road materials is rather complicated. Fatigue is one of the main failures of cementitious materials like stabilised red sand, consequently, should be examined further.

3) The deterioration of roadways sometimes comes from hydraulic pumping beneath the surface layer. Ground water can move upward along the cracking lines in the cementatious base layer. This cracking is a major problem for the cementatiouly stabilised base course. HCTCRB has been developed for avoiding this problem while this research recreates many

properties within stabilised red sand; cracking characteristics have not been investigated. This would be another interesting point for the further study.

4) Based on the results of laboratory tests and field performance data, a numerical model for the stabilised red sand could be developed and used in design to predict the actual behaviour of the material.

5) Utilising in large volume of by-product such as red sand, fly ash, and lime kiln dust may causes the lack of uniformity of the mixture at disposal sites. New methods need to be developed for controlling the properties of these substances.

6) For washed and carbonated red sand, if proposed for waterfront structure (seawall) use then the dynamic behaviour needs assessment. For this, the cyclic triaxial test would be employed and its constitutive model also would be established for use in analysing and predicting its behaviour in the design process.

7) Liquefaction resistance of red sand for dynamic condition (wave action and earthquake) would be investigated in further study.

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APPENDIX A

UNPROCESSED RED SAND CHARACTERISATION

APPENDIX A

(Unprocessed Red Sand)

Appendix A.1. Sieve Analysis

Sample Location:	**Alcoa , Perth WA**	**Sample Number: A-01**
Sample Description:	Unprocessed Red Sand	
Total Mass of Air Dried Sample (g):		900.00
Dry Mass of Sample pre washing (g):		594.64
Dry Mass of Sample After Washing (g):		560.9
Loss of Mass through Washing (g):		33.7
Total % Passing 0.075mm Sieve:		6.01

Sieve Analysis

Sieve Opening	Wt. Sieve gm.	Wt. Sieve + Soil gm.	Soil Retained gm.	Cumulative Retained gm.	Cumulative Retained %	Percent Finer %
4.75	479.75	479.75	0.00	0.00	0.00	**100.00**
2.36	481.40	481.40	0.00	0.00	0.00	**100.00**
1.18	389.46	390.95	1.49	1.49	0.25	**99.75**
0.60	359.34	414.44	55.10	56.59	9.52	**90.48**
0.43	383.46	465.85	82.39	138.98	23.37	**76.63**
0.30	316.14	451.20	135.06	274.04	46.09	**53.91**
0.150	302.09	549.40	247.31	521.35	87.67	**12.33**
0.075	336.02	375.60	39.58	560.93	94.33	**5.67**
0	262.10	263.00	0.90	561.83	94.48	**5.52**

Appendix A: Unprocessed Red sand Characterisation

Sample Location:	Alcoa , Perth WA	Sample Number: A-02
Sample Description:	Unprocessed Red Sand	
Total Mass of Air Dried Sample (g):		900.00
Dry Mass of Sample pre washing (g):		504.32
Dry Mass of Sample After Washing (g):		476.9
Loss of Mass through Washing (g):		27.4
Total % Passing 0.075mm Sieve:		5.75

Sieve Analysis

Sieve Opening	Wt. Sieve gm.	Wt. Sieve + Soil gm.	Soil Retained gm.	Cumulative Retained gm.	Cumulative Retained %	Percent Finer %
4.75	479.75	479.75	0.00	0.00	0.00	**100.00**
2.36	481.40	483.61	2.21	2.21	0.44	**99.56**
1.18	389.46	392.21	2.75	4.96	0.98	**99.02**
0.60	359.34	416.96	57.62	62.58	12.41	**87.59**
0.43	383.46	458.91	75.45	138.03	27.37	**72.63**
0.30	316.14	431.56	115.42	253.45	50.26	**49.74**
0.150	302.09	495.81	193.72	447.17	88.67	**11.33**
0.075	336.02	365.90	29.88	477.05	94.59	**5.41**
0	262.10	262.60	0.50	477.55	94.69	**5.31**

Appendix A: Unprocessed Red sand Characterisation

Sample Location:	**Alcoa , Perth WA**	**Sample Number: A-03**
Sample Description:	Unprocessed Red Sand	
Total Mass of Air Dried Sample (g):		900.00
Dry Mass of Sample pre washing (g):		505.35
Dry Mass of Sample After Washing (g):		480.8
Loss of Mass through Washing (g):		24.6
Total % Passing 0.075mm Sieve:		5.12

Sieve Analysis

Sieve Opening	Wt. Sieve gm.	Wt. Sieve + Soil gm.	Soil Retained gm.	Cumulative Retained gm.	Cumulative Retained %	Percent Finer %
4.75	479.75	480.95	1.20	1.20	0.24	**99.76**
2.36	481.40	483.05	1.65	2.85	0.56	**99.44**
1.18	389.46	392.36	2.90	5.75	1.14	**98.86**
0.60	359.34	431.15	71.81	77.56	15.35	**84.65**
0.43	383.46	462.00	78.54	156.10	30.89	**69.11**
0.30	316.14	432.50	116.36	272.46	53.92	**46.08**
0.150	302.09	480.50	178.41	450.87	89.22	**10.78**
0.075	336.02	365.82	29.80	480.67	95.12	**4.88**
0.000	262.10	263.30	1.20	481.87	95.35	**4.65**

Sample Location:	**Alcoa , Perth WA**	**Sample Number: A-04**
Sample Description:	Unprocessed Red Sand	
Total Mass of Air Dried Sample (g):		900.00
Dry Mass of Sample pre washing (g):		535.85
Dry Mass of Sample After Washing (g):		513.4
Loss of Mass through Washing (g):		22.5
Total % Passing 0.075mm Sieve:		4.38

Sieve Analysis

Sieve Opening	Wt. Sieve gm.	Wt. Sieve + Soil gm.	Soil Retained gm.	Cumulative Retained gm.	Cumulative Retained %	Percent Finer %
4.75	479.75	481.15	1.40	1.40	0.26	**99.74**
2.36	481.40	482.00	0.60	2.00	0.37	**99.63**
1.18	389.46	392.82	3.36	5.36	1.00	**99.00**
0.60	359.34	454.55	95.21	100.57	18.77	**81.23**
0.43	383.46	472.30	88.84	189.41	35.35	**64.65**
0.30	316.14	434.35	118.21	307.62	57.41	**42.59**
0.150	302.09	478.70	176.61	484.23	90.37	**9.63**
0.075	336.02	364.50	28.48	512.71	95.68	**4.32**
0.00	262.10	263.48	1.38	514.09	95.94	**4.06**

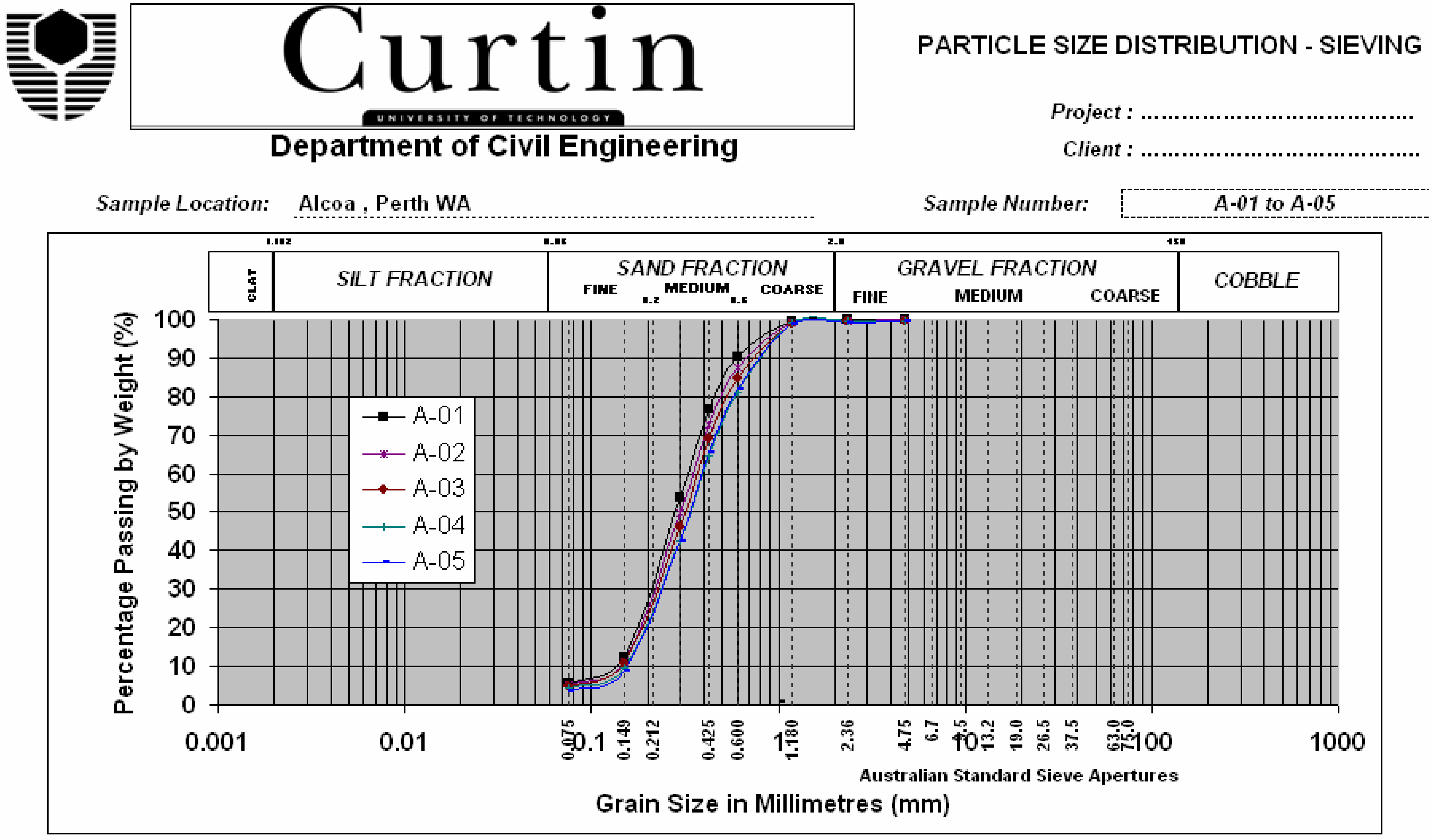
Appendix A: Unprocessed Red sand Characterisation

Sample Location:	**Alcoa , Perth WA**	**Sample Number: A-05**
Sample Description:	Unprocessed Red Sand	
Total Mass of Air Dried Sample (g):		900.00
Dry Mass of Sample pre washing (g):		501.25
Dry Mass of Sample After Washing (g):		485.0
Loss of Mass through Washing (g):		16.3
Total % Passing 0.075mm Sieve:		3.35

Sieve Analysis

Sieve Opening	Wt. Sieve gm.	Wt. Sieve + Soil gm.	Soil Retained gm.	Cumulative Retained gm.	Cumulative Retained %	Percent Finer %
4.75	479.75	481.95	2.20	2.20	0.44	**99.56**
2.36	481.40	482.70	1.30	3.50	0.70	**99.30**
1.18	389.46	392.72	3.26	6.76	1.35	**98.65**
0.60	359.34	443.35	84.01	90.77	18.11	**81.89**
0.43	383.46	466.15	82.69	173.46	34.61	**65.39**
0.30	316.14	429.65	113.51	286.97	57.25	**42.75**
0.150	302.09	471.75	169.66	456.63	91.10	**8.90**
0.075	336.02	362.64	26.62	483.25	96.41	**3.59**
0	262.10	263.44	1.34	484.59	96.68	**3.32**

Appendix A: Unprocessed Red sand Characterisation



Appendix A : Sieve analysis Chart

Appendix A.2. Standard Compaction Test

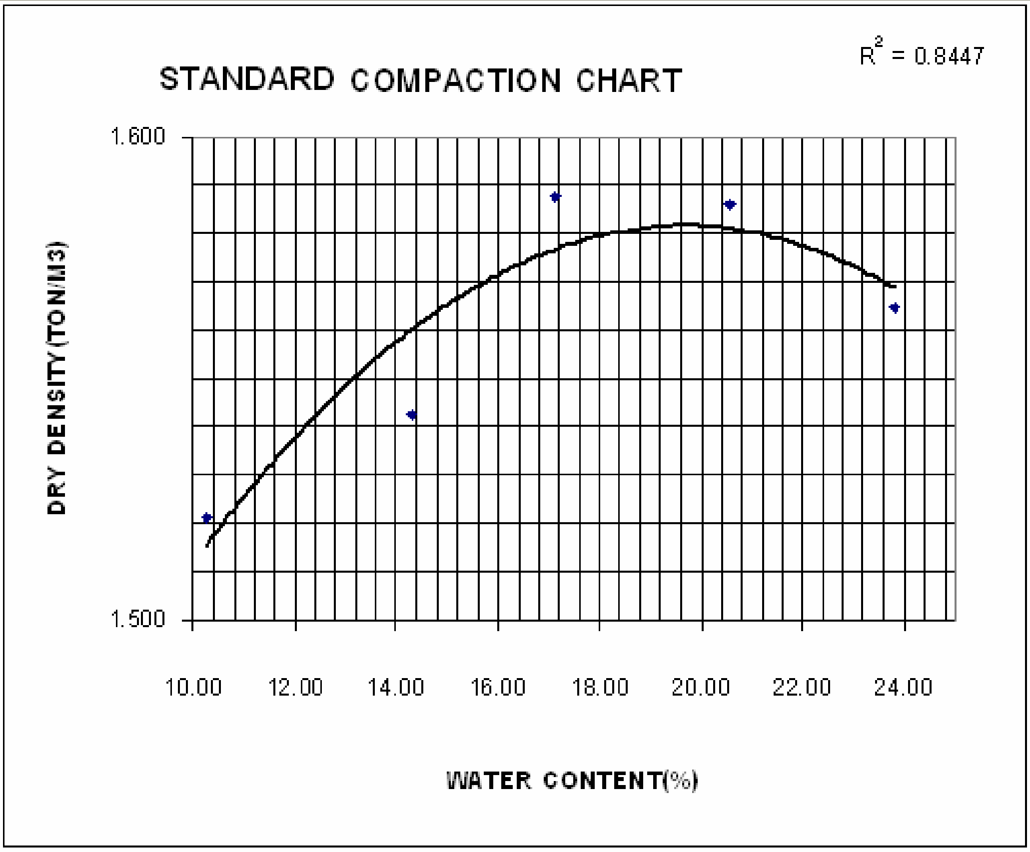
Soil Description:	A-01	Source of Soil: tested Date:	Alcoa, WA 15/5/2006

Compaction Method:	Standard		Mould Dimension:	dia105.0x115.5mm	
Hammer weight	4.9	Kg	Dropped Height	450	mm
No. of Layer	3		No. of Blow	25	blows/layer

COMPACTION		Test no.	1	2	3	4	5
Assumed Water Content		%	10	14	18	22	26
Weight of Air Dry Soil Use		g	3500	3500	3500	3500	3500
Water Content of Air Dry Soil		%	0	0	0	0	0
Amount of Water Added		cm^3	350	490	630	770	910
Weight of Wet Soil + Mould		g	5567	5653	5750	5802	5827
Weight of Mould		g	3889	3889	3889	3889	3889
Weight of Wet Soil,W		g	1678	1764	1861	1913	1938
Wet Density,	$r_{(total)} = W/V$	g/cm^3	1.68	1.76	1.86	1.91	1.94
Dry Soil Density	$r_{(dry)} = \frac{100 r_{(total)}}{(100+w)}$	g/cm^3	**1.521**	**1.542**	**1.588**	**1.586**	**1.565**

WATER CONTENT	container number	A1	A2	A3	A4	A5
Weight of Wet Soil + Container	g	84.66	70.24	80.94	85.29	85.97
Weight of Dry Soil + Container	g	78.95	63.86	71.89	73.86	73.12
Weight of Water	g	5.71	6.38	9.05	11.43	12.85
Weight of Container	g	23.27	19.26	19.08	18.26	19.14
Weight of Dry Soil	g	55.68	44.6	52.81	55.6	53.98
Water Content,w	%	**10.26**	**14.30**	**17.14**	**20.56**	**23.81**

RESULT OF SOIL COMPACTION TEST	Standard						
Test Number		1	2	3	4	5	6
Dry Density, □(dry)	ton/m^3	1.52	1.54	1.59	1.59	1.56	0.000
Water Content,w	%	10.26	14.30	17.14	20.56	23.81	0.00



Appendix A: Standard Compaction Chart

Appendix A.3. Modified Compaction Test

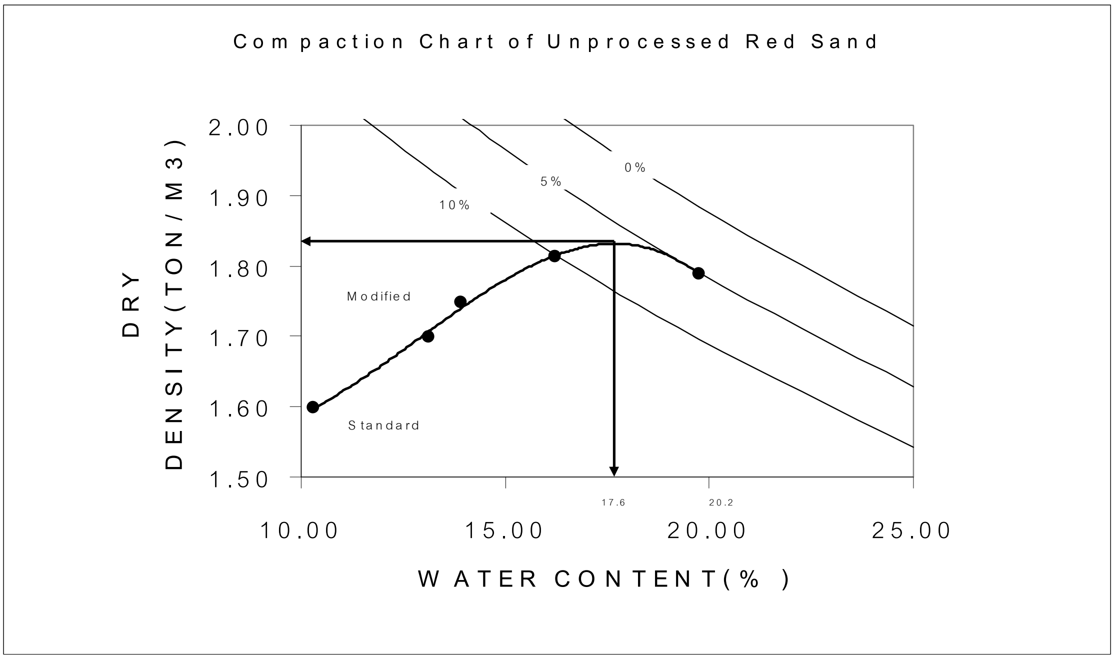
Soil Description:	A-05	Source of Soil: tested Date:	Alcoa, WA 15/5/2006

Compaction Method:	Modified	Mould Dimension:	dia105.0x115.5mm
Hammer weight	4.9 Kg	Dropped Height	450 mm
No. of Layer	5	No. of Blow	25 blows/layer

COMPACTION		test no.	1	2	3	4	5
Assumed Water Content		%	10	14	18	22	26
Weight of Air Dry Soil Use		g	3000	3000	3000	3000	3000
Water Content of Air Dry Soil		%	0	0	0	0	0
Amount of Water Added		cm^3	300	120	120	120	120
Weight of Wet Soil + Mould		g	5654	5812	5883	5998	6033
Weight of Mould		g	3890	3890	3890	3890	3890
Weight of Wet Soil,W		g	1922	1993	2108	2143	2143
Wet Density,	$r_{(total)} = W/V$	g/cm^3	1.92	1.99	2.11	2.14	2.14
Dry Soil Density	$r_{(dry)} = \frac{100r_{(total)}}{(100+w)}$	g/cm^3	**1.599**	**1.698**	**1.749**	**1.813**	**1.789**
WATER CONTENT		container number	A1	A2	A3	A4	A5
Weight of Wet Soil + Container		g	96.29	68.83	74.16	72.39	49.68
Weight of Dry Soil + Container		g	89.47	63.08	67.43	64.83	44.64
Weight of Water		g	6.82	5.75	6.73	7.56	5.04
Weight of Container		g	23.23	19.23	19.03	18.26	19.12
Weight of Dry Soil		g	66.24	43.85	48.4	46.57	25.52
Water Content,w		**%**	**10.30**	**13.11**	**13.90**	**16.23**	**19.75**

Appendix A: Unprocessed Red sand Characterisation

RESULT OF SOIL COMPACTION TEST	Modified						
Test Number			1	2	3	4	5
Dry Density,	$\square_{(dry)}$	ton/m^3	1.599	1.698	1.749	1.813	1.789
Water Content,w		%	10.3	13.11	13.90	16.23	19.75



Appendix A: Modified Compaction chart

Appendix A.4. Particle Density test

Alcoa , Perth WA					
Sample Location:					
Sample Description: Unprocessed Res Sand					
For Material Passing the 2.36 mm Sieve					
Test No:	Unit	Symbol	1	2	3
Picnometer No:	gms				
Mass of Pycnometer + dry soil:	gms		215.72	237.16	449.5
Mass of Pycnometer	gms		98.81	98.84	186.89
Mass of Dry Soil	gms	A	116.91	138.32	262.61
Mass of Pycnometer + Water	gms	B	347.52	348.42	686.55
A+B	gms	C	464.43	486.74	949.16
Mass of Pycnometer + Soil + Water	gms	D	425.7	441.23	862.12
Volume of Soil (Displaced Water) = (C-D)	cm^3	V	38.73	45.51	87.04
Particle Density = M/V	g/cm^3		3.02	3.04	3.02
Average Particle Density	g/cm^3		**3.03**		

Appendix A.5. Falling Head, Modified Compaction Permeability Test

Sample Description: Unprocessed Red Sand			Modified Compaction		
Data	Unit	Symbol	1	Stand Pipe Data	
Length	cm	L	11.35	Internal Diameter (cm)	3.13
Diameter	cm		10.145	Stand Pipe Area (cm2)	7.69
Area	cm2	A	80.79	Calculations for falling head K = 2.3(La/AT) Log(H1/H2)	
Wet Mass of soil	gms		1911		
Moisture content of soil	%		18.34		
Dry Mass of soil	gms		-	Calculations for constant head K = QL/AtH	
Volume of Soil	cm3		917.00		
Dry Density	g/cm3		1.76		

Falling Head test

Time 1	Time 2	Date	Elps(T) sec.	temp Deg.C	H1 cm	H2 cm	H1/H2	K cm/sec
0	660		660	17.00	54.75	49.75	1.10	**1.57E-04**

Appendix A.6. California Bearing Ratio test (Unsoaked, Modified Compaction)

Soil Description: Unprocessed red sand			Source of Soil: tested Date:	Kwinana Refinery,WA 10/7/2006	
Compaction Method: Modified			Mould Dimension:	dia152x178 mm	
Hammer weight	4.9	Kg	Dropped Height	450	mm
No. of Layer	5		No. of Blow	53	blows/layer

COMPACTION MOISTURE CONTENTS				
WATER CONTENT	container number		A4	A5
Weight of Wet Soil + Container		g	62.4	63.85
Weight of Dry Soil + Container		g	57.22	59.11
Weight of Water		g	5.18	4.74
Weight of Container		g	18.31	19.2
Weight of Dry Soil		g	38.91	39.91
Water Content,w		%	13.31	11.88
Average Water Content,w		%	12.59	
AFTER COMPACTION DENSITY				
Weight of Wet Soil + Mould + Base Plate		g	11093	
Weight of Mould + Base Plate		g	7194	
Weight of Wet Soil,W		g	3899	
Wet Density, $r_{(total)}=$	W/V	g/cm^3	1.84	
Dry Soil Density $r_{(dry)}=$	$\frac{100r_{(total)}}{(100+w)}$	g/cm^3	1.63	

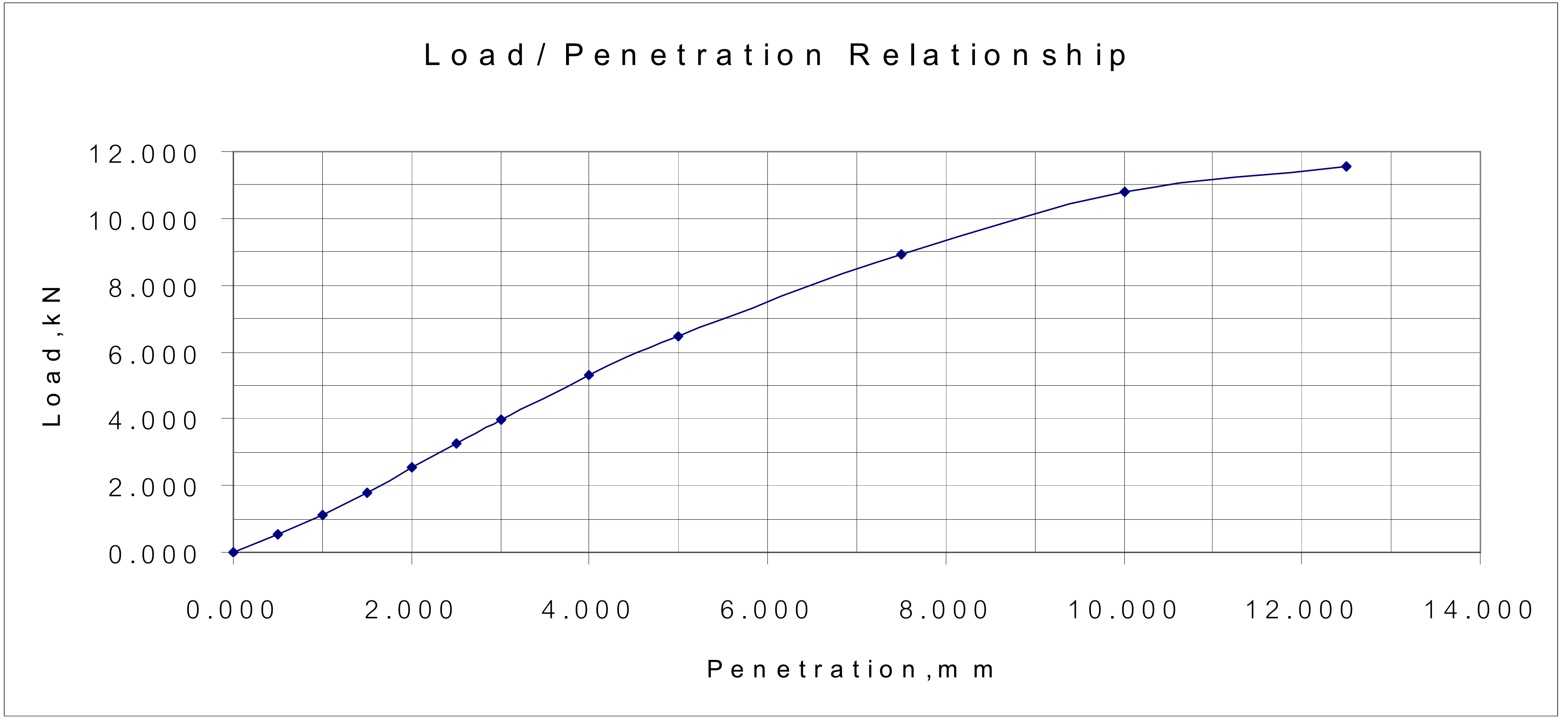
Appendix A: Unprocessed Red sand Characterisation

Mould No.	a-1	
Blows/Layer	53	
Surcharge	4.5 kg	
PENETRATION mm	Force Gauge Reading kN	Pressure kPa
0.000	0.00	0.00
0.500	0.55	225.83
1.000	1.12	459.87
1.500	1.80	739.08
2.000	2.53	1038.82
2.500	3.25	1334.45
3.000	3.95	1621.87
4.000	5.30	2176.19
5.000	6.48	2660.69
7.500	8.93	3666.67
10.000	10.78	4426.28
12.500	11.55	4742.44

Corrected Load at:		
2.5 mm Penetration =	*3.25*	kN
5.0 mm Penetration =	*6.48*	kN

CBR =	$\frac{\text{Corrected Load Value}}{\text{Standard Load}}$ x100	Standard load 2.5 mm Penetration =13.2 kN Standard load 5.0 mm Penetration =19.8 kN
CBR Value at 95%	Max. Dry Density(1.83 ton/m^3) = 1.74	

CBR at 2.5 mm (%)	24.62
CBR at 5.0 (%)	32.73
Dry Density (ton/m3)	1.63
Percent Swell (%)	0.00



The CBR Value of This soil is as		
CBR	**32.73**	**%**

Appendix A: Un-soaked CBR chart

Appendix A.7. California Bearing Ratio test (Soaked, Modified Compaction)

Soil Description: Unprocessed red sand	Source of Soil: Kwinana Refinery,WA tested Date: 10/7/2006
Compaction Method: Modified Hammer weight 4.9 Kg No. of Layer 5	Mould Dimension: dia152x178 mm Dropped Height 450 mm No. of Blow 53 blows/layer

COMPACTION MOISTURE CONTENTS			
WATER CONTENT	container number	4	5
Weight of Wet Soil + Container	g	76.6	92.33
Weight of Dry Soil + Container	g	70.19	83.81
Weight of Water	g	6.41	8.52
Weight of Container	g	23.97	22.94
Weight of Dry Soil	g	46.22	60.87
Water Content,w	%	13.87	14.00
Average Water Content,w	%	13.93	

AFTER COMPACTION DENSITY				
Weight of Wet Soil + Mould + Base Plate			g	11305
Weight of Mould + Base Plate			g	7199
Weight of Wet Soil,W			g	4106
Wet Density,	$r_{(total)}$=	W/V	g/cm^3	1.93
Dry Soil Density	$r_{(dry)}$=	$\frac{100r_{(total)}}{(100+w)}$	g/cm^3	1.70

			Before Soaking			After Soaking		
WATER CONTENT	container number		39	45	11	2	3	4
Weight of Wet Soil + Container		g	99.23	100.42	103.12	103.12	98.32	99.11
Weight of Dry Soil + Container		g	90.96	91.56	94.21	93.44	89.96	90.12
Weight of Water		g	8.27	8.86	8.91	9.68	8.36	8.99
Weight of Container		g	22.34	20.13	21.22	21.01	23.62	23.62
Weight of Dry Soil		g	68.62	71.43	72.99	72.43	66.34	66.5
Water Content,w		%	12.05	12.40	12.21	13.36	12.60	13.52
Weight of Wet Soil + Mould					g	11305		
Weight of Soaked Soil + Mould					g	11500		
Mass of Water Absorbed ,Wa					g	195		
Percent Water Absorbed,					Wa(100+w)/W	5.41		

Appendix A: Unprocessed Red sand Characterisation

Mould No.	a-1	
Blows/Layer	53	
Surcharge kg	4.5	
PENETRATION mm	Force Gauge Reading kN	Pressure kPa
0.000	0.00	0.00
0.500	0.75	307.95
1.000	1.68	689.81
1.500	2.92	1198.95
2.000	4.34	1782.01
2.500	5.74	2356.85
3.000	7.17	2944.01
4.000	9.20	3777.53
5.000	10.60	4352.37
7.500	13.62	5592.38
10.000	15.52	6372.53
12.500	15.95	6549.09

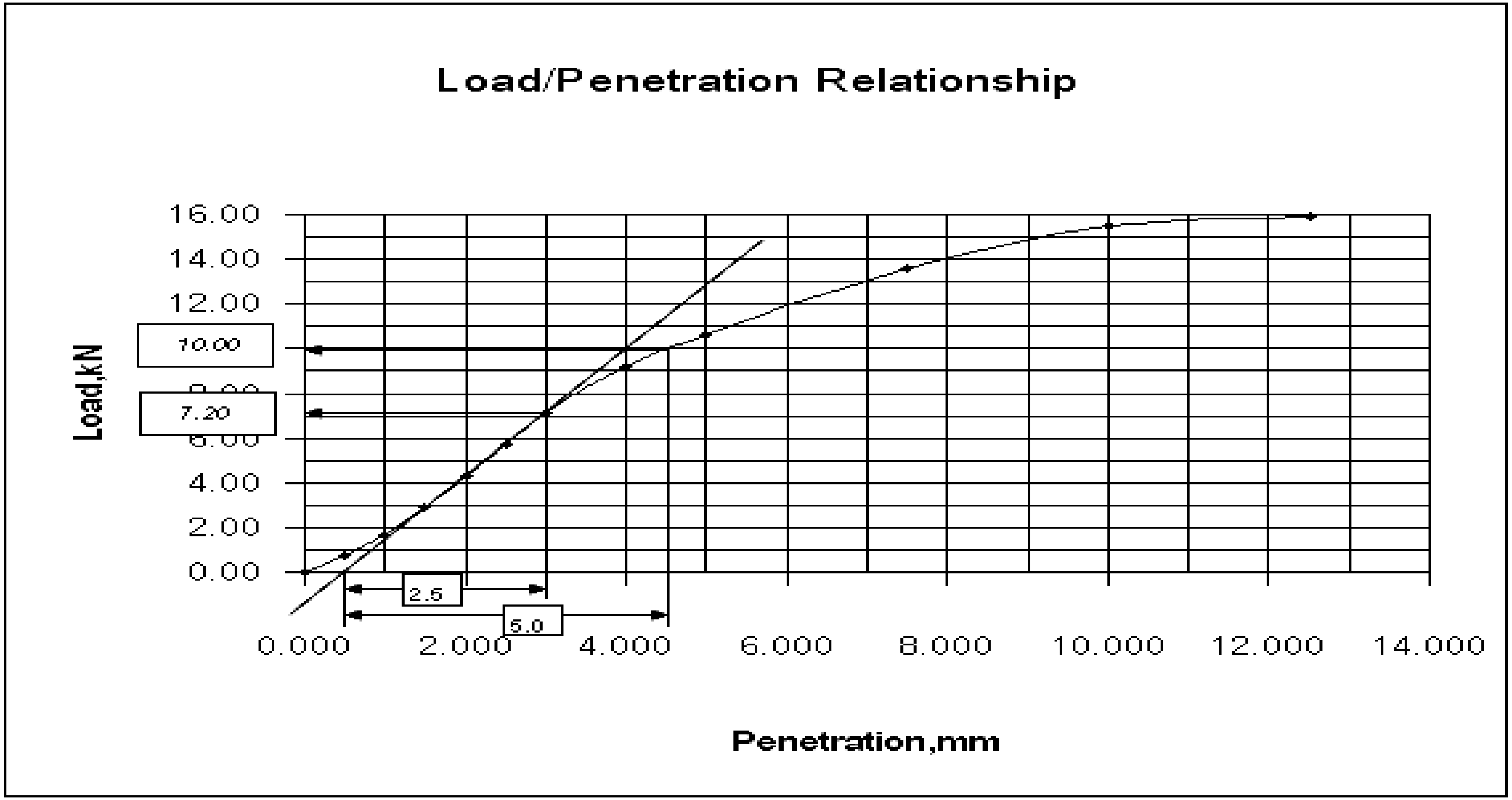
Corrected Load at:		
2.5 mm Penetration =	*7.20*	kN
5.0 mm Penetration =	*10.00*	kN

$$CBR = \frac{\text{Corrected Load Value}}{\text{Standard Load}} x100$$

Standard load 2.5 mm Penetration =13.2 kN
Standard load 5.0 mm Penetration =19.8 kN

CBR Value at 95% Max. Dry Density(1.83 ton/m^3) = 1.74

CBR at 2.5 mm (%)	54.55
CBR at 5.0 (%)	50.51
Dry Density (ton/m3)	1.70
Percent Swell (%)	0.01



The CBR value of This soil is as	
CBR	**54.55 %**

Appendix A : Soaked CBR Chart

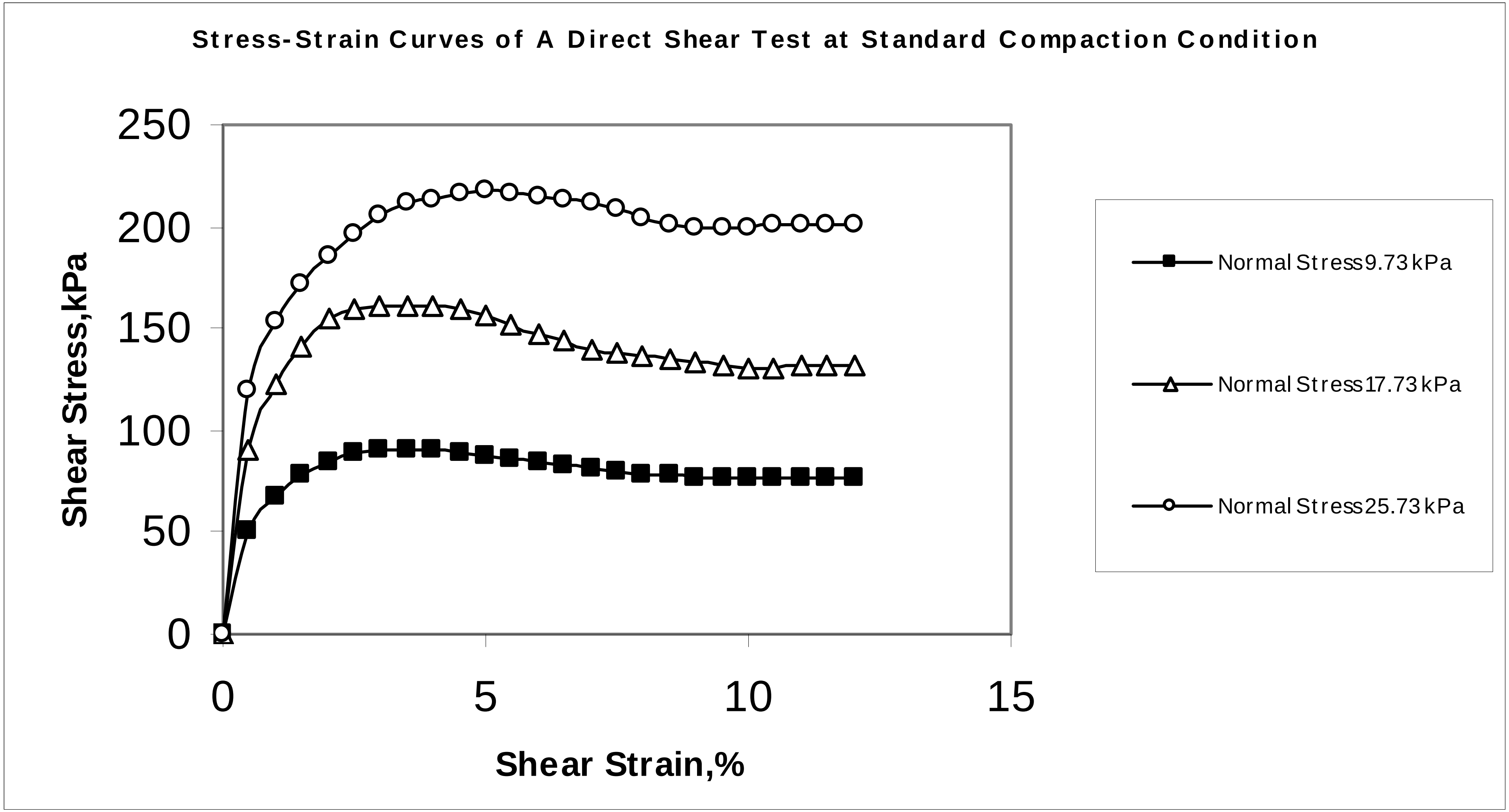
Appendix A.8. Shear Box Test (Standard Compaction)

20kg		L_1	50	L_2	50
cumulative displacement	Vertical movement (mm)	Proving ring Reading	F=1.405 N/div	Corrected Area A' = L (L - δ)	Shear Stress (F x 1000)/A
0	0	0	0	0	0
0.25	-0.03	103	144.715	2487.500	58.177
0.5	-0.05	119	167.195	2475.000	67.554
0.75	-0.05	130	182.650	2462.500	74.173
1	-0.05	146	205.130	2450.000	83.727
1.25	-0.05	153	214.965	2437.500	88.191
1.5	-0.03	155	217.775	2425.000	89.804
1.75	0	155	217.775	2412.500	90.269
2	0.02	154	216.370	2400.000	90.154
2.25	0.05	150	210.750	2387.500	88.272
2.5	0.085	147	206.535	2375.000	86.962
2.75	0.115	144	202.320	2362.500	85.638
3	0.127	140	196.700	2350.000	83.702
3.25	0.132	137	192.485	2337.500	82.347
3.5	0.136	134	188.270	2325.000	80.976
3.75	0.15	131	184.055	2312.500	79.591
4	0.155	128	179.840	2300.000	78.191
4.25	0.159	127	178.435	2287.500	78.004
4.5	0.159	125	175.625	2275.000	77.198
4.75	0.159	124	174.220	2262.500	77.003
5	0.159	123	172.815	2250.000	76.807
5.25	0.159	122	171.410	2237.500	76.608
5.5	0.159	122	171.410	2225.000	77.038
5.75	0.159	121	170.005	2212.500	76.838
6	0.159	120	168.600	2200.000	76.636

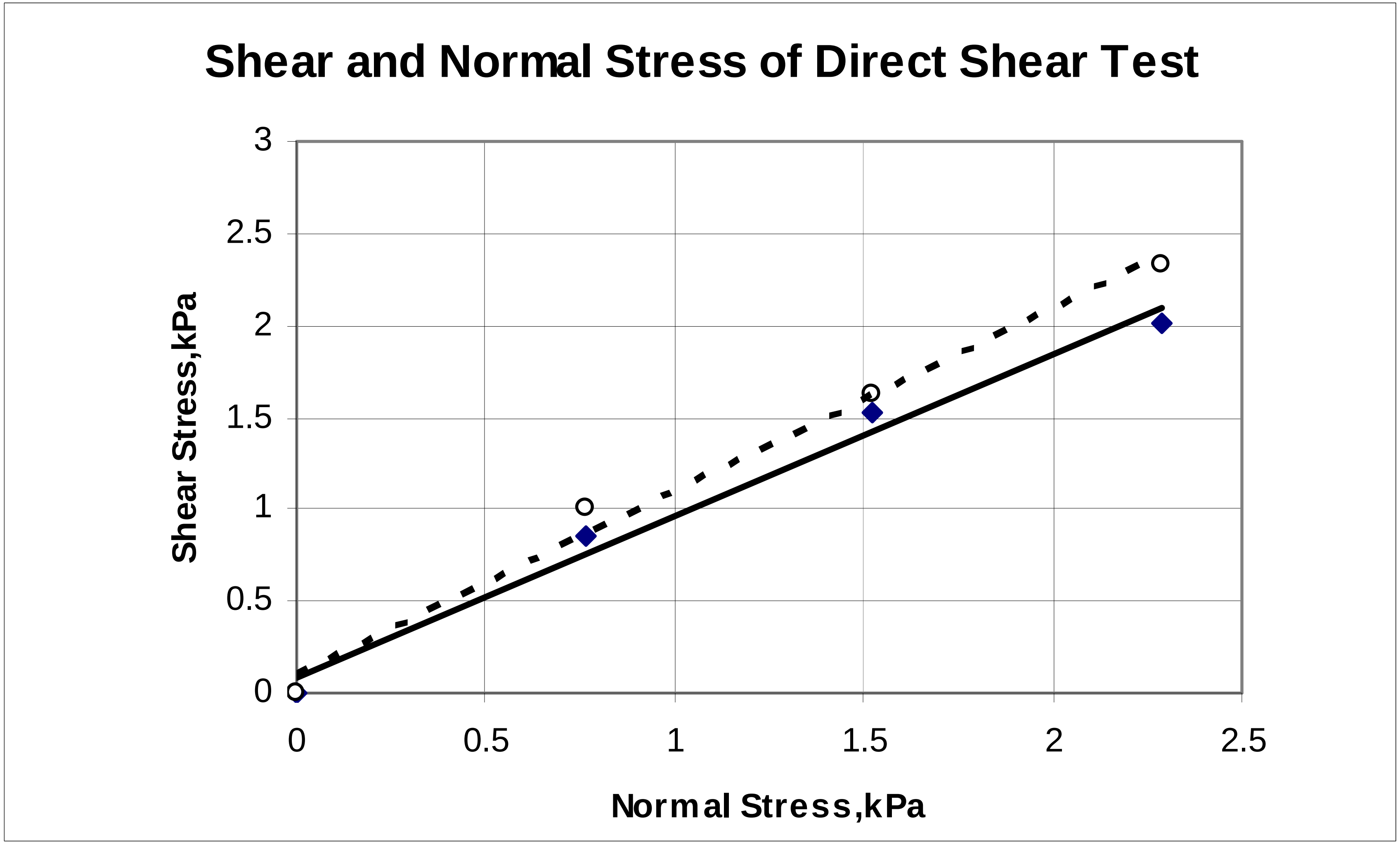
40kg		L_1	50	L_2	50
cumulative displacement	Vertical movement (mm)	Proving ring Reading	F=1.405 N/div	Corrected Area A' = L (L - δ)	Shear Stress (F x 1000)/A
0	0	0	0	0	0
0.25	-0.005	160	224.800	2487.500	90.372
0.5	-0.005	215	302.075	2475.000	122.051
0.75	-0.005	247	347.035	2462.500	140.928
1	0	269	377.945	2450.000	154.263
1.25	0.01	276	387.780	2437.500	159.089
1.5	0.04	278	390.590	2425.000	161.068
1.75	0.06	277.5	389.888	2412.500	161.611
2	0.1	274	384.970	2400.000	160.404
2.25	0.13	270	379.350	2387.500	158.890
2.5	0.17	264	370.920	2375.000	156.177
2.75	0.2	255	358.275	2362.500	151.651
3	0.21	247	347.035	2350.000	147.674
3.25	0.22	240	337.200	2337.500	144.257
3.5	0.23	230	323.150	2325.000	138.989
3.75	0.235	226.5	318.233	2312.500	137.614
4	0.24	223	313.315	2300.000	136.224
4.25	0.245	219	307.695	2287.500	134.511
4.5	0.25	215	302.075	2275.000	132.780
4.75	0.25	212	297.860	2262.500	131.651
5	0.25	209	293.645	2250.000	130.509
5.25	0.25	208.5	292.943	2237.500	130.924
5.5	0.25	208	292.240	2225.000	131.344
5.75	0.25	208	292.240	2212.500	132.086
6	0.25	207	290.835	2200.000	132.198
6.25	0.25	208	292.240	2187.500	133.595
6.5	0.25	207	290.835	2175.000	133.717
6.75	0.24	207	290.835	2162.500	134.490
7	0.245	209	293.645	2150.000	136.579
7.25	0.22	211.5	297.158	2137.500	139.021

Appendix A: Unprocessed Red sand Characterisation

60kg		L_1	507	L_2	507
cumulative displacement	Vertical movement (mm)	Proving ring Reading	F=1.405 N/div	Corrected Area A' = L (L - δ)	Shear Stress (F x 1000)/A
0	0	0	0	0	0.000
0.25	-0.01	228	320.340	2487.500	120.000
0.5	-0.025	255	358.275	2475.000	154.000
0.75	-0.035	279	391.995	2462.500	172.000
1	-0.035	305	428.525	2450.000	186.000
1.25	-0.035	334	469.270	2437.500	196.000
1.5	-0.03	350	491.750	2425.000	205.000
1.75	-0.03	359	504.395	2412.500	211.000
2	-0.015	365	512.825	2400.000	213.677
2.25	-0.01	368	517.040	2387.500	216.561
2.5	0.015	368	517.040	2375.000	217.701
2.75	0.045	364	511.420	2362.500	216.474
3	0.07	359	504.395	2350.000	214.636
3.25	0.1	355	498.775	2337.500	213.380
3.5	0.12	350	491.750	2325.000	211.505
3.75	0.14	343	481.915	2312.500	208.396
4	0.145	335	470.675	2300.000	204.641
4.25	0.145	328	460.840	2287.500	201.460
4.5	0.15	322	452.410	2275.000	198.862
4.75	0.15	322	452.410	2262.500	199.960
5	0.15	324	455.220	2250.000	200.120
5.25	0.15	325	456.625	2237.500	200.480
5.5	0.15	325	456.625	2225.000	200.560
5.75	0.15	325	456.625	2212.500	200.640
6	0.15	324	455.220	2200.000	200.960
6.25	0.15	324	455.220	2187.500	0.000
6.5	0.15	321	451.005	2175.000	120.000
6.75	0.15	320	449.600	2162.500	154.000
7	0.15	321	451.005	2150.000	172.000
7.25	0.15	321	451.005	2137.500	186.000
7.5	0.15	321	451.005	2125.000	196.000
7.75	0.15	322	452.410	2112.500	205.000
8	0.14	324	455.220	2100.000	211.000
8.25	0.13	324	455.220	2087.500	213.677
8.5	0.12	326	458.030	2075.000	216.561
8.75	0.1	328	460.840	2062.500	217.701
9	0.085	330	463.650	2050.000	216.474
9.25	0.075	333	467.865	2037.500	214.636
9.5	0.06	333	467.865	2025.000	213.380
9.75	0.045	334	469.270	2012.500	211.505
10	0	335	470.675	2000.000	208.396



Appendix A: Standard Direct Shear Chart



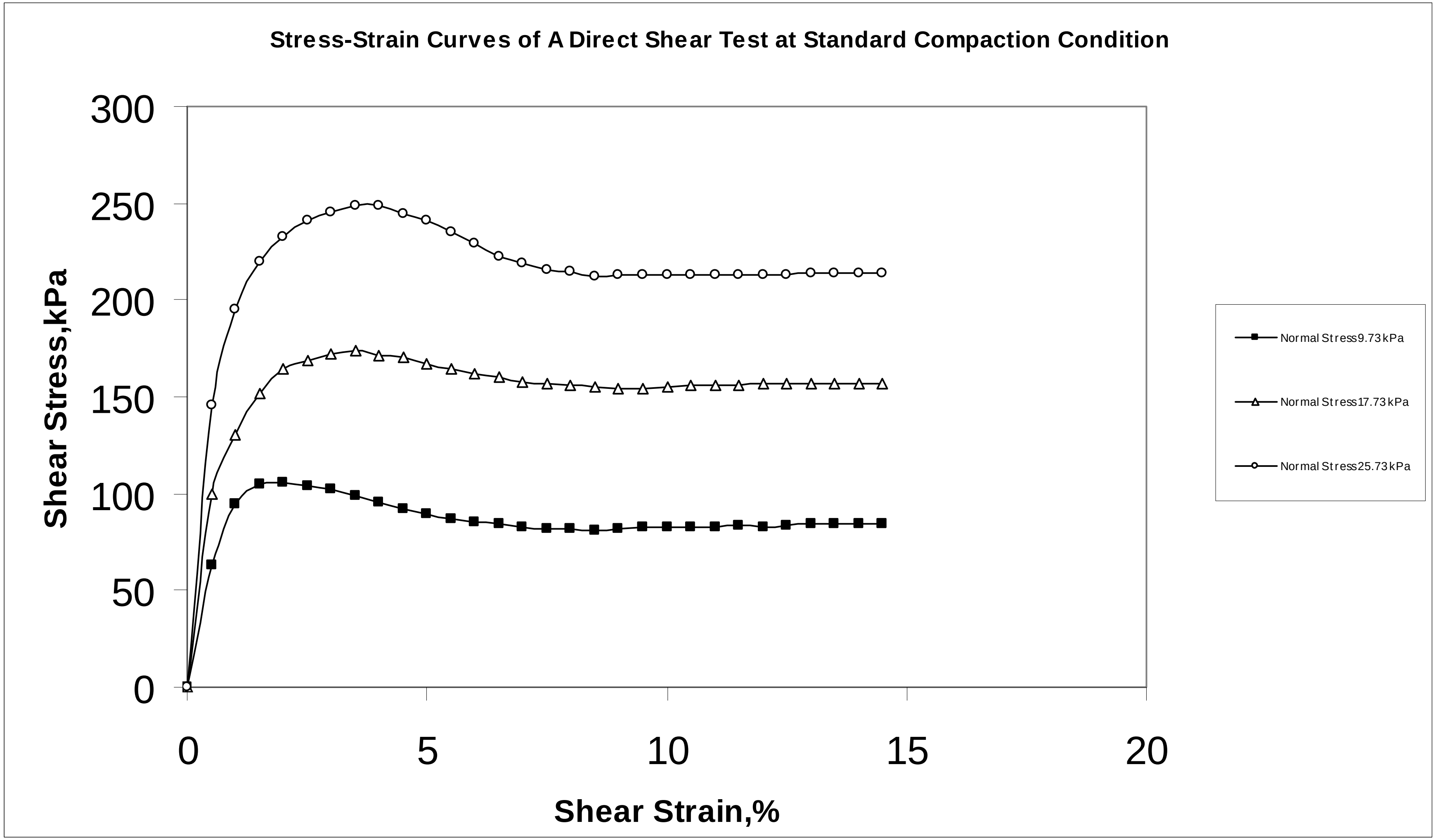
Appendix A: Stress strain Curve

Appendix A.9. Shear Box Test (modified Compaction)

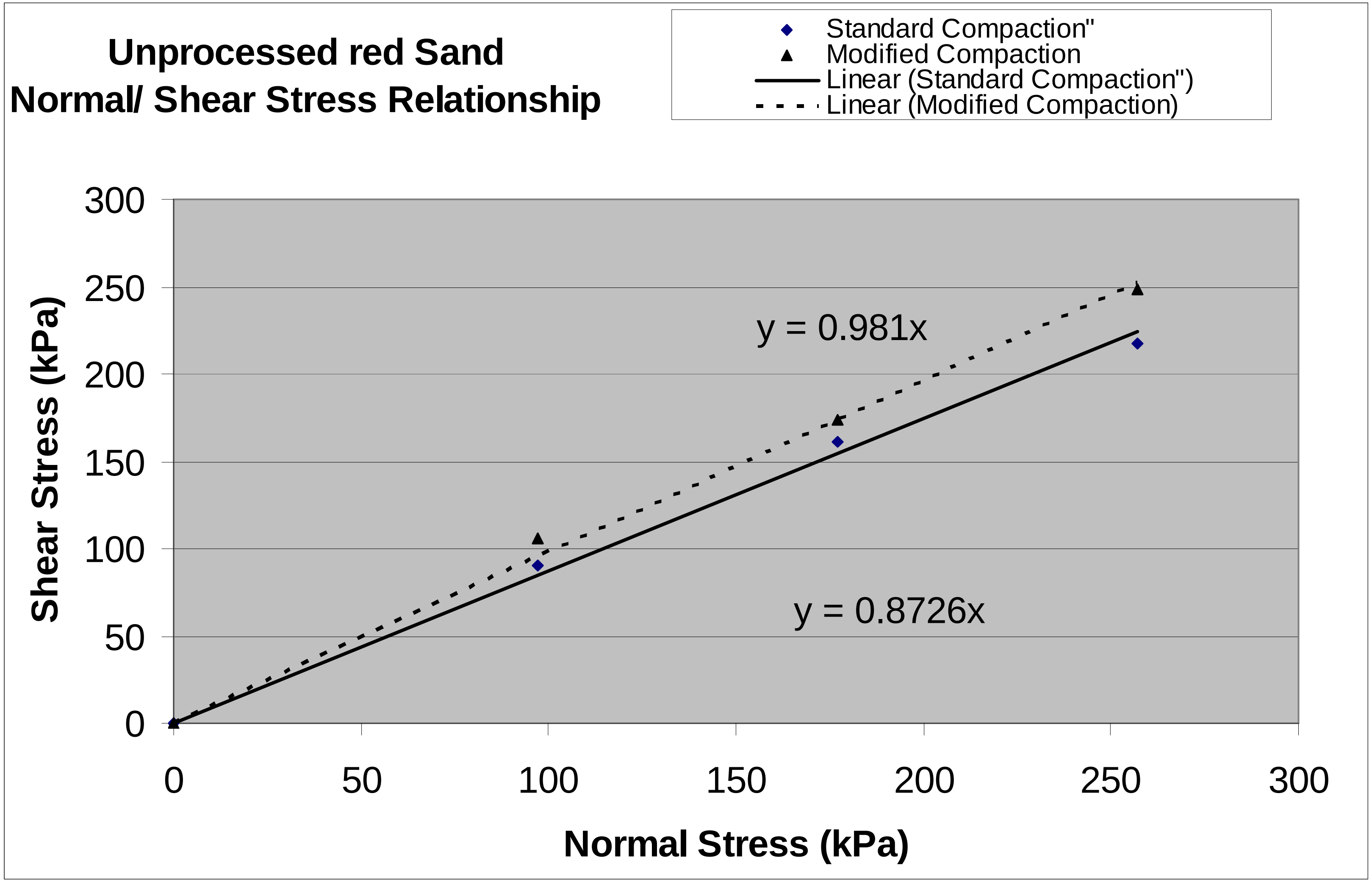
20kg		L_1	50	L_2	50
cumulative displacement	Vertical movement (mm)	Proving ring Reading	F=1.405 N/div	Corrected Area A' = L (L - δ)	Shear Stress (F x 1000)/A
0	0	0	0	0	0
0.25	-0.03	112	157.360	2487.500	63.260
0.5	-0.05	167	234.635	2475.000	94.802
0.75	-0.05	183	257.115	2462.500	104.412
1	-0.05	184	258.520	2450.000	105.518
1.25	-0.05	181	254.305	2437.500	104.330
1.5	-0.03	177	248.685	2425.000	102.551
1.75	0	170	238.850	2412.500	99.005
2	0.02	163	229.015	2400.000	95.423
2.25	0.05	156	219.180	2387.500	91.803
2.5	0.085	151	212.155	2375.000	89.328
2.75	0.115	146	205.130	2362.500	86.828
3	0.127	142	199.510	2350.000	84.898
3.25	0.132	140	196.700	2337.500	84.150
3.5	0.136	137	192.485	2325.000	82.789
3.75	0.15	135	189.675	2312.500	82.022
4	0.155	134	188.270	2300.000	81.857
4.25	0.159	132	185.460	2287.500	81.075
4.5	0.159	133	186.865	2275.000	82.138
4.75	0.159	133	186.865	2262.500	82.592
5	0.159	133	186.865	2250.000	83.051
5.25	0.159	132	185.460	2237.500	82.887
5.5	0.159	131	184.055	2225.000	82.721
5.75	0.159	131	184.055	2212.500	83.189
6	0.159	130	182.650	2200.000	83.023

40kg		L_1	50	L_2	50
		Proving	F=1.405	Corrected	
cumulative	Vertical movement	ring	N/div	Area	Shear Stress
displacement	(mm)	Reading		A' = L (L - δ)	(F x 1000)/A
0	0	0	0	0	0
0.25	-0.005	176	247.280	2487.500	99.409
0.5	-0.005	217	304.885	2475.000	123.186
0.75	-0.005	266	373.730	2462.500	151.769
1	0	287	403.235	2450.000	164.586
1.25	0.01	293	411.665	2437.500	168.888
1.5	0.04	297	417.285	2425.000	172.076
1.75	0.06	298	418.690	2412.500	173.550
2	0.1	293	411.665	2400.000	171.527
2.25	0.13	289	406.045	2387.500	170.071
2.5	0.17	282	396.210	2375.000	166.825
2.75	0.2	276	387.780	2362.500	164.140
3	0.21	271	380.755	2350.000	162.023
3.25	0.22	266	373.730	2337.500	159.884
3.5	0.23	261	366.705	2325.000	157.723
3.75	0.235	258	362.490	2312.500	156.752
4	0.24	255	358.275	2300.000	155.772
4.25	0.245	253	355.465	2287.500	155.395
4.5	0.25	250	351.250	2275.000	154.396
4.75	0.25	249	349.845	2262.500	154.628
5	0.25	249	349.845	2250.000	155.487
5.25	0.25	249	349.845	2237.500	156.355
5.5	0.25	247	347.035	2225.000	155.971
5.75	0.25	246	345.630	2212.500	156.217
6	0.25	245	344.225	2200.000	156.466
6.25	0.25	247	347.035	2187.500	158.645
6.5	0.25	248	348.440	2175.000	160.202
6.75	0.24	246	345.630	2162.500	159.829
7	0.245	245	344.225	2150.000	160.105
7.25	0.22	246	345.630	2137.500	161.698

60kg		L_1	507	L_2	507
		Proving	F=1.405	Corrected	
cumulative	Vertical movement	ring	N/div	Area	Shear Stress
displacement	(mm)	Reading		A' = L (L - δ)	(F x 1000)/A
0	0	0	0	0	0
0.25	-0.01	270	379.350	2487.500	152.503
0.5	-0.025	323	453.815	2475.000	183.360
0.75	-0.035	374	525.470	2462.500	213.389
1	-0.035	406	570.430	2450.000	232.829
1.25	-0.035	419	588.695	2437.500	241.516
1.5	-0.03	424	595.720	2425.000	245.658
1.75	-0.03	427	599.935	2412.500	248.678
2	-0.015	425	597.125	2400.000	248.802
2.25	-0.01	416	584.480	2387.500	244.808
2.5	0.015	408	573.240	2375.000	241.364
2.75	0.045	395	554.975	2362.500	234.910
3	0.07	383	538.115	2350.000	228.985
3.25	0.1	370	519.850	2337.500	222.396
3.5	0.12	362	508.610	2325.000	218.757
3.75	0.14	355	498.775	2312.500	215.686
4	0.145	358	502.990	2300.000	218.691
4.25	0.145	346	486.130	2287.500	212.516
4.5	0.15	345	484.725	2275.000	213.066
4.75	0.15	342	480.510	2262.500	212.380
5	0.15	343	481.915	2250.000	214.184
5.25	0.15	344	483.320	2237.500	216.009
5.5	0.15	344	483.320	2225.000	217.222
5.75	0.15	343	481.915	2212.500	217.815
6	0.15	343	481.915	2200.000	219.052
6.25	0.15	346	486.130	2187.500	222.231
6.5	0.15	346	486.130	2175.000	223.508
6.75	0.15	347	487.535	2162.500	225.450
7	0.15	348	488.940	2150.000	227.414
7.25	0.15	350	491.750	2137.500	230.058
7.5	0.15	349	490.345	2125.000	230.751
7.75	0.15	348	488.940	2112.500	231.451
8	0.14	348	488.940	2100.000	232.829
8.25	0.13	349	490.345	2087.500	234.896
8.5	0.12	350	491.750	2075.000	236.988
8.75	0.1	348	488.940	2062.500	237.062
9	0.085	348	488.940	2050.000	238.507
9.25	0.075	346	486.130	2037.500	238.591
9.5	0.06	346	486.130	2025.000	240.064
9.75	0.045	349	490.345	2012.500	243.650
10	0	347	487.535	2000.000	243.768



Appendix A: Modified Direct Shear Chart



Appendix A 9-1: Strength Parameter graph

APPENDIX B

WASHED AND CARBONATED RED SAND CHARACTERISATION

APPENDIX B

(Washed and Carbonated Red Sand)

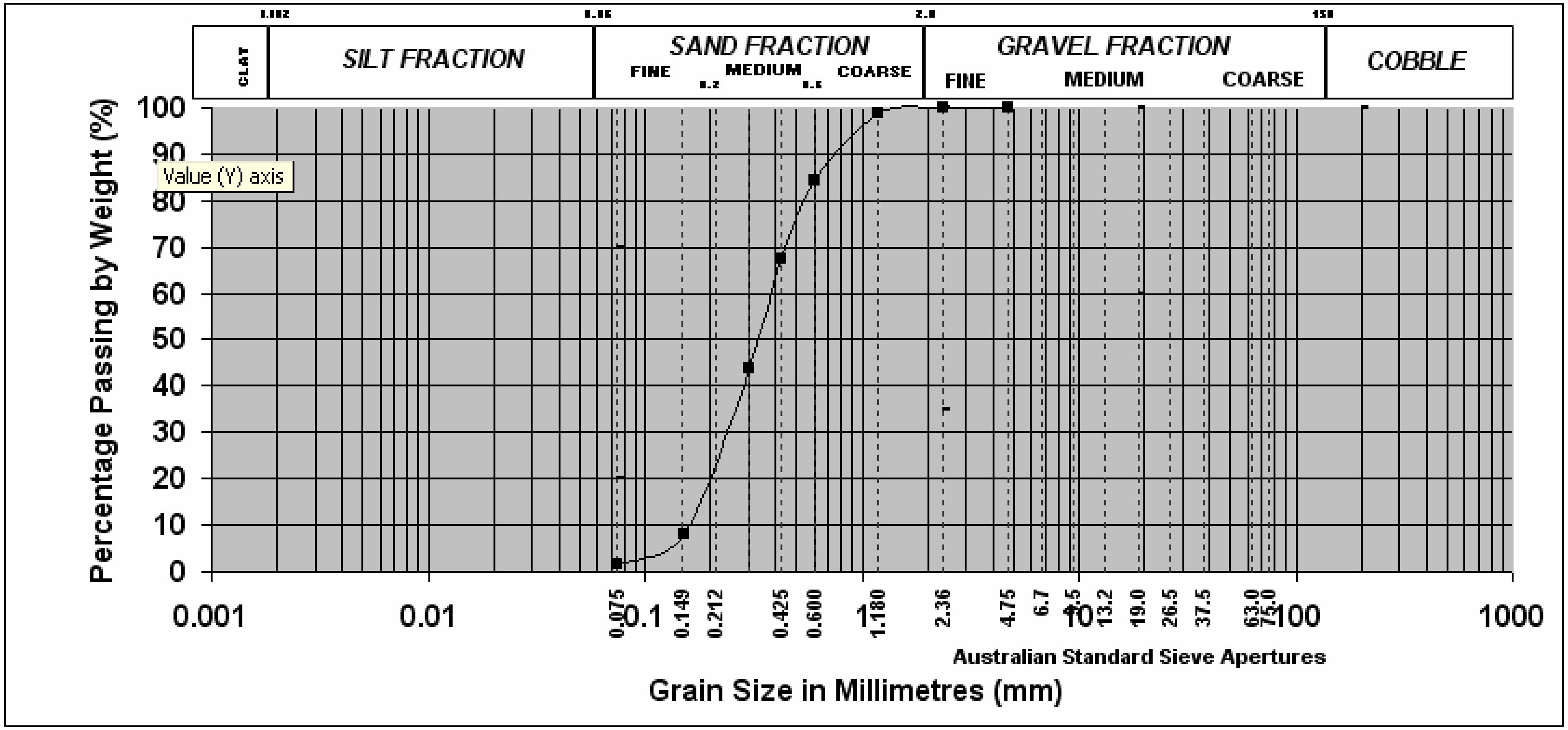
Appendix B.1. Sieve Analysis

Sample Location:	**Alcoa , Perth WA**	***Sample Number:* A-01**
Sample Description:	Unprocessed Red Sand	
Total Mass of Air Dried Sample (g):		700.00
Dry Mass of Sample pre washing (g):		700.00
Dry Mass of Sample After Washing (g):		700.0
Loss of Mass through Washing (g):		0.0
Total % Passing 0.075mm Sieve:		0.00

Sieve Analysis

Sieve Opening	Wt. Sieve gm.	Wt. Sieve + Soil gm.	Soil Retained gm.	Cumulative Retained gm.	Cumulative Retained %	Percent Finer %
4.75	479.75	479.75	0.00	0.00	0.00	**100.00**
2.36	481.20	482.15	0.95	0.95	0.14	**99.86**
1.18	446.30	452.90	6.60	7.55	1.08	**98.92**
0.60	424.20	527.45	103.25	110.80	15.83	**84.17**
0.43	337.12	453.30	116.18	226.98	32.43	**67.57**
0.30	374.54	539.80	165.26	392.24	56.03	**43.97**
0.150	349.70	601.75	252.05	644.29	92.04	**7.96**
0.075	337.08	380.50	43.42	687.71	98.24	**1.76**
0	271.78	283.60	11.82	699.53	99.93	**0.07**

Appendix B: Washed and Carbonated Red Sand Characterisation



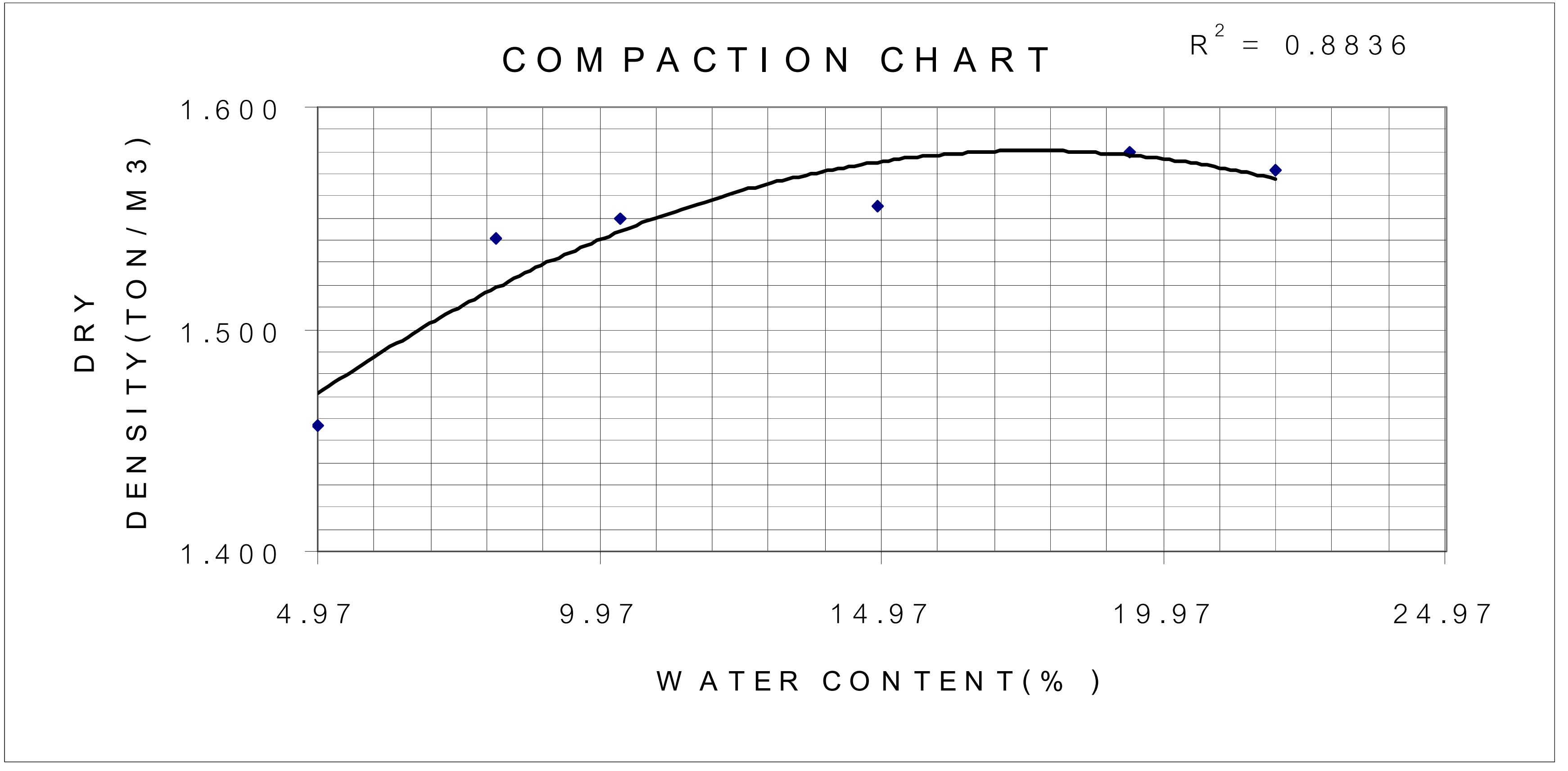
Appendix B : Sieve Analysis Chart

Appendix B.2. Standard Compaction Test

Compaction Method: Standard			Mold Dimension:	dia105.0x115.5mm	
Hammer weight	4.9	Kg	Dropped Height	450	mm
No. of Layer	3		No. of Blow	25	blows/layer

COMPACTION	test no.	1	2	3	4	5	6
Assumed Water Content	%	4	8	10	14	18	20
Weight of Air Dry Soil Use	g	3500	2500	2500	2500	2500	2500
Water Content of Air Dry Soil	%	0	0	0	0	0	0
Amount of Water Added	cm^3	140	200	250	350	450	500
Weight of Wet Soil + Mould	g	6062	4190	4234	4311	4410	4408
Weight of Mould	g	4532	2523	2523	2523	2523	2523
Weight of Wet Soil,W	g	1530	1667	1711	1788	1887	1885
Wet Density, $r_{(total)}$ = W/V	g/cm^3	1.53	1.67	1.71	1.79	1.89	1.88
Dry Soil Density $r_{(dry)} = \frac{100 r_{(total)}}{(100+w)}$	g/cm^3	**1.457**	**1.541**	**1.550**	**1.555**	**1.580**	**1.545**
WATER CONTENT container number		A1	A2	A3	A4	A5	A6
Weight of Wet Soil + Container	g	315.72	367.62	381.2	318.54	293.78	215.67
Weight of Dry Soil + Container	g	302.8	343.94	350.7	283.06	253.02	183.59
Weight of Water	g	12.92	23.68	30.5	35.48	40.76	28.97
Weight of Container	g	42.19	52.42	55.88	44.83	42.68	37.48
Weight of Dry Soil	g	260	291.52	294.82	238.23	210.34	146.11
Water Content,w	%	**4.97**	**8.12**	**10.35**	**14.89**	**19.38**	**21.96**

RESULT OF SOIL COMPACTION TEST								
Test Number			1	2	3	4	5	6
Dry Density,	r(dry)	ton/m^3	1.46	1.54	1.55	1.56	1.58	1.572
Water Content,w		%	4.97	8.12	10.35	14.89	19.38	21.96



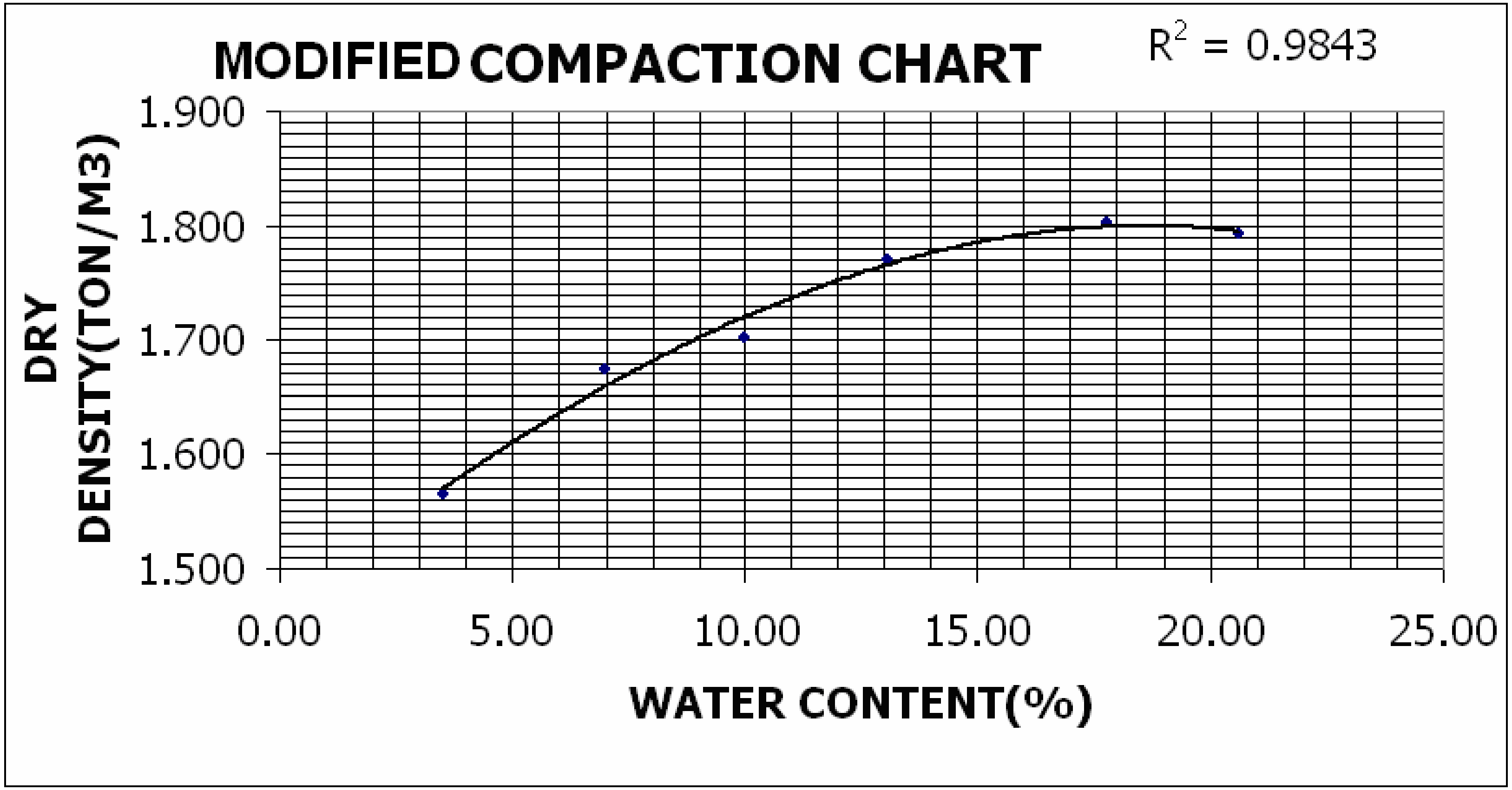
Appendix B: Standard Compaction Chart

Appendix B.3. Modified Compaction Test

Compaction Method: Modified			Mold Dimension:	dia105.0x115.5mm	
Hammer weight	4.9	Kg	Dropped Height	450	mm
No. of Layer	5		No. of Blow	25	blows/layer

COMPACTION	test no.	1	2	3	4	5	6
Assumed Water Content	%	4	8	12	16	20	24
Weight of Air Dry Soil Use	g	3500	3500	3500	3500	3500	3500
Water Content of Air Dry Soil	%	1	1	1	1	1	1
Amount of Water Added	cm^3	105	245	385	525	665	805
Weight of Wet Soil + Mould	g	5601	6325	6405	6534	6657	6695
Weight of Mould	g	3979	4532	4532	4532	4532	4532
Weight of Wet Soil,W	g	1622	1793	1873	2002	2125	2163
Wet Density, $r_{(total)}$ = W/V	g/cm^3	1.62	1.79	1.87	2.00	2.12	2.16
Dry Soil Density $r_{(dry)} = \frac{100r_{(total)}}{(100+w)}$	g/cm^3	**1.566**	**1.675**	**1.702**	**1.770**	**1.804**	**1.793**
WATER CONTENT container number		A3	8	23	37	24	12
Weight of Wet Soil + Container	g	83.47	104.25	90.7	94.49	108.38	131.27
Weight of Dry Soil + Container	g	81.43	98.94	84.56	86.21	95.62	112.86
Weight of Water	g	2.04	5.31	6.14	8.28	12.76	18.41
Weight of Container	g	23.03	22.78	23	22.76	23.78	23.37
Weight of Dry Soil	g	58.4	76.16	61.56	63.45	71.84	89.49
Water Content,w	%	**3.49**	**6.97**	**9.97**	**13.05**	**17.76**	**20.57**

RESULT OF SOIL COMPACTION TEST							
Test Number			1	2	3	4	5	6
Dry Density, $r_{(dry)}$	ton/m^3	1.57	1.68	1.70	1.77	1.80	1.793
Water Content,w	%	3.49	6.97	9.97	13.05	17.76	20.57



Appendix B: Modified Compaction Chart

Appendix B.4. Particle Density test

Sample Location:	**Alcoa , Perth WA**	***Sample Number:***		
Date of Test:				
Project:	**FYP**			
Sample Description:	Washed & Carbonated Red Sand			
For Material Passing the 2.36 mm Sieve				
Test No:	Unit	Symbol	1	2
Picnometer No:	gms			
Mass of Pycnometer + dry soil:	gms		356.46	256.7
Mass of Pycnometer	gms		145.26	95.42
Mass of Dry Soil	gms	A	211.2	161.28
Mass of Pycnometer + Water	gms	B	648.95	347.88
A+B	gms	C	860.15	509.16
Mass of Pycnometer + Soil + Water	gms	D	791.7	456.7
Volume of Soil (Displaced Water) = (C-D)	cm3	V	68.45	52.46
Particle Density = M/V	g/cm3		3.09	3.07
Average Particle Density	g/cm3		**3.08**	

Appendix B.5. Constant Head, Modified Compaction Permeability Test

Test Sample Data					
Data	Unit	Symbol	1	Stand Pipe Data	
Length	cm	L	21	Internal Diameter (cm)	6.34
Diameter	cm		6.34	Stand Pipe Area (cm2)	31.55
Area	cm^2	A	31.57		

Constant Head Test								
Volume of water collected	cm3	Q	17.5	16.5	16	15.5	15.5	K = QL/AtH
Time taken	sec	t	11	30	30	30	30	
Constant Head	cm	H	1130	1130	1130	1130	1130	
Temperature	deg.C		20	20	20	20	20	
Permeability (k)	cm/sec		0.0009	0.0003	0.0003	0.0003	0.0003	

Appendix B.6. California Bearing Ratio test (Unsoaked, Modified Compaction)

Compaction Method: Modified			Mold Dimension:	dia152x178 mm	
Hammer weight	4.9	Kg	Dropped Height	450	mm
No. of Layer	5		No. of Blow	53	blows/layer

COMPACTION MOISTURE CONTENTS			
WATER CONTENT container number		23	37
Weight of Wet Soil + Container	g	129.3	123.6
Weight of Dry Soil + Container	g	113.76	108.12
Weight of Water	g	15.54	15.48
Weight of Container	g	23.05	22.76
Weight of Dry Soil	g	90.71	85.36
Water Content,w	%	17.13	18.13
Average Water Content,w	%	17.63	
AFTER COMPACTION DENSITY			
Weight of Wet Soil + Mould + Base Plate	g	11204	
Weight of Mould + Base Plate	g	7186	
Weight of Wet Soil,W	g	4018	
Wet Density, $r_{(total)}$= W/V	g/cm^3	1.89	
Dry Soil Density $r_{(dry)}$= $\frac{100r_{(total)}}{(100+w)}$	g/cm^3	1.62	

Mould No.	a-1	
Blows/Layer	53	
Surcharge kg	4.5	
PENETRATION mm	Force Gauge Reading kN	Pressure kPa
0.000	0.00	0.00
0.500	2.19	899.22
1.000	3.46	1420.68
1.500	4.50	1847.70
2.000	5.23	2147.44
2.500	5.96	2447.18
3.000	6.91	2837.25
4.000	8.23	3379.25
5.000	9.45	3880.18
7.500	11.35	4660.32
10.000	12.21	5013.44
12.500	12.98	5329.60

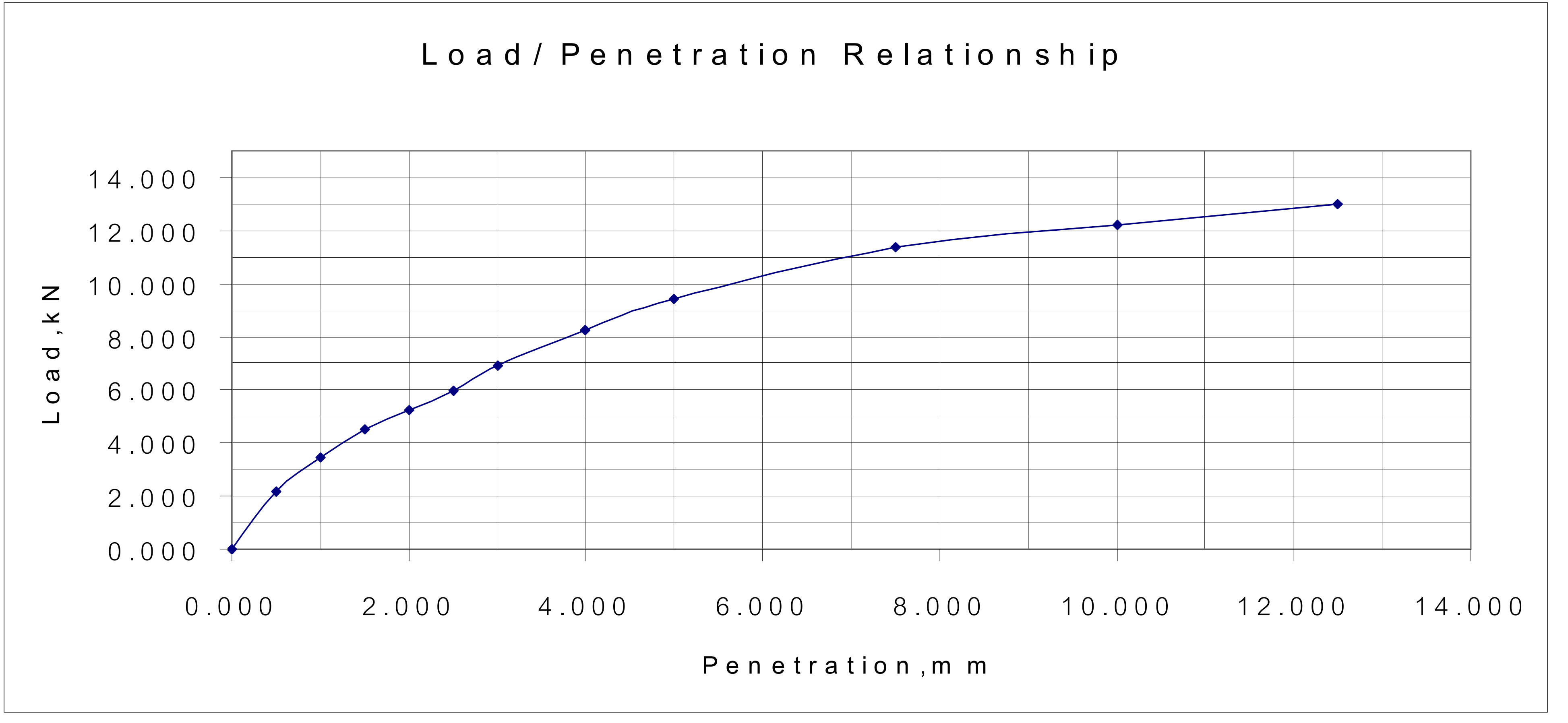
Corrected Load at:		
2.5 mm Penetration =	*5.96*	kN
5.0 mm Penetration =	*9.45*	kN

$$CBR = \frac{\text{Corrected Load Value}}{\text{Standard Load}} \times 100$$

Standard load 2.5 mm Penetration =13.2 kN
Standard load 5.0 mm Penetration =19.8 kN

CBR Value at 95% Max. Dry Density(1.83 ton/m^3) = 1.74

CBR at 2.5 mm (%)	45.15
CBR at 5.0 (%)	47.65
Dry Density (ton/m3)	1.63
Percent Swell (%)	0.00



The CBR Value of This soil is as		
CBR	**47.65**	**%**

Appendix B: Un-soaked CBR chart

Appendix B.7. California Bearing Ratio test (Soaked, Modified Compaction)

Compaction Method: Modified						
			Mold Dimension:	dia152x178 mm		
Hammer weight	4.9	Kg	Dropped Height	450	mm	
No. of Layer	5		No. of Blow	53	blows/layer	

COMPACTION MOISTURE CONTENTS		
WATER CONTENT	container number	5
Weight of Wet Soil + Container	g	182.41
Weight of Dry Soil + Container	g	164.57
Weight of Water	g	17.84
Weight of Container	g	42.57
Weight of Dry Soil	g	122
Water Content,w	%	14.62
Average Water Content,w	%	13.93

AFTER COMPACTION DENSITY		
Weight of Wet Soil + Mould + Base Plate	g	11291
Weight of Mould + Base Plate	g	7184
Weight of Wet Soil,W	g	4107
Wet Density, $r_{(total)} = W/V$	g/cm^3	1.93
Dry Soil Density $r_{(dry)} = \frac{100r_{(total)}}{(100+w)}$	g/cm^3	1.68

		Before Soaking			After Soaking		
WATER CONTENT container number		112	113	A5	1	2	3
Weight of Wet Soil + Container	g	98.95	101.8	104.1	103.2	99.97	102.6
Weight of Dry Soil + Container	g	90.75	92.63	95.65	94.92	90.05	93.12
Weight of Water	g	8.2	9.17	8.45	8.28	9.92	9.45
Weight of Container	g	22.34	20.13	21.22	21.01	23.62	23.62
Weight of Dry Soil	g	68.62	72.5	74.43	73.91	66.43	69.53
Water Content,w	%	11.99	12.65	11.35	11.20	14.93	13.59
Weight of Wet Soil + Mould				g	11305		
Weight of Soaked Soil + Mould				g	11500		
Mass of Water Absorbed ,Wa				g	195		
Percent Water Absorbed, Wa(100+w)/W					5.41		

Mould No.		a-1	
Blows/Layer		53	
Surcharge	kg	4.5	
PENETRATION mm		Force Gauge Reading kN	Pressure kPa
0.000		0.00	0.00
0.500		1.94	796.57
1.000		3.53	1449.42
1.500		4.80	1970.88
2.000		5.98	2455.39
2.500		6.89	2829.04
3.000		7.86	3227.32
4.000		9.50	3900.71
5.000		11.08	4549.46
7.500		13.62	5592.38
10.000		15.52	6372.53
12.500		15.95	6549.09

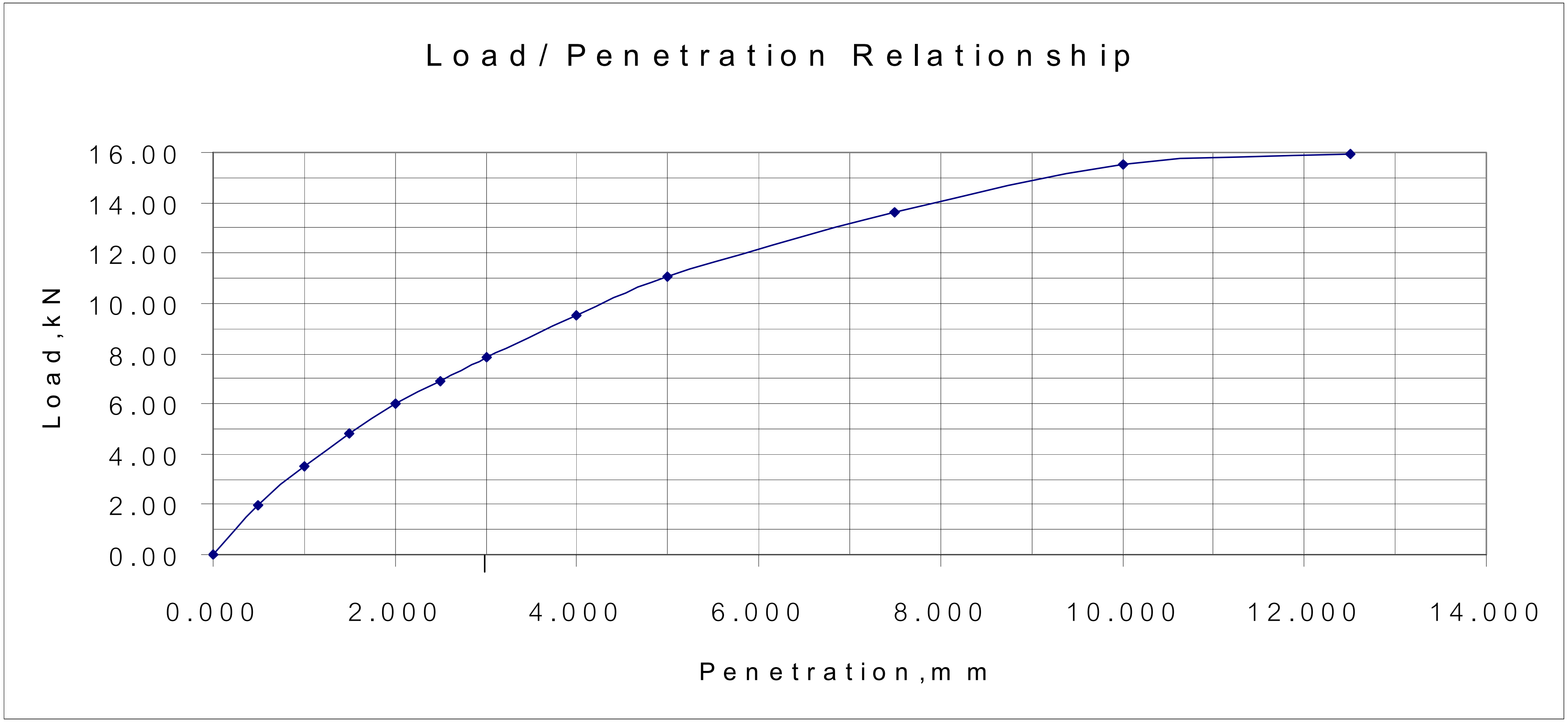
Corrected Load at:		
2.5 mm Penetration =	***6.89***	**kN**
5.0 mm Penetration =	***11.08***	**kN**

$$CBR = \frac{\text{Corrected Load Value}}{\text{Standard Load}} \times 100$$

Standard load 2.5 mm Penetration =13.2 kN
Standard load 5.0 mm Penetration =19.8 kN

CBR Value at 95% Max. Dry Density(1.83 ton/m^3)= 1.74

CBR at 2.5 mm (%)	52.20
CBR at 5.0 (%)	55.96
Dry Density (ton/m3)	1.70
Percent Swell (%)	0.01



The CBR Value of This soil is as		
CBR	**55.98**	**%**

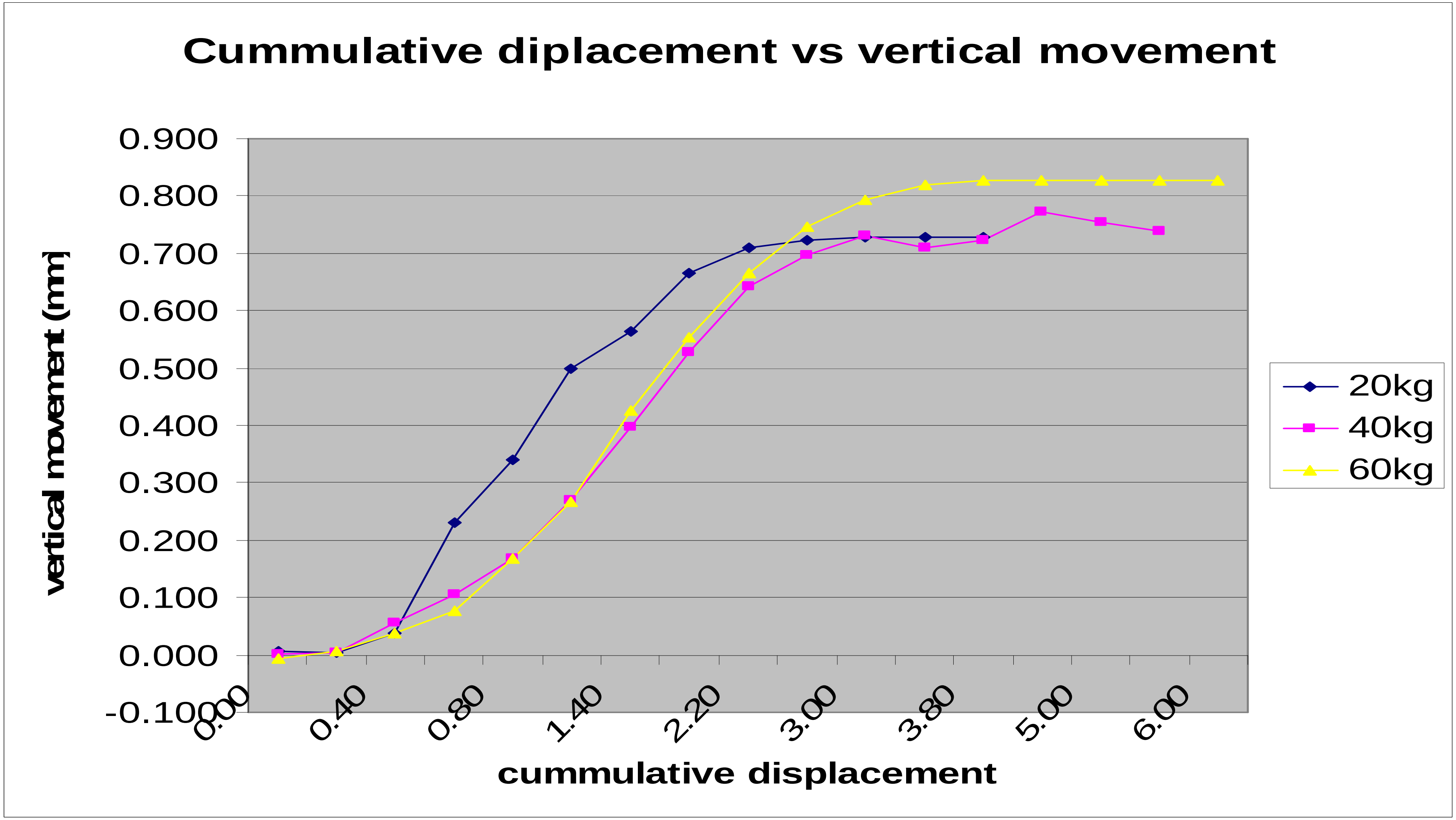
Appendix B: Soaked CBR chart

Appendix B.8. Shear Box Test (Standard Compaction)

10kg		L_1	51	L_2	51
	Vertical	Proving	F=1.405	Corrected	
cumulative displ.	movement	ring	N/div	Area	Shear Stress
Mm(A*0.01)	(mm)	Reading		A' = L (L - δ)	(F x 1000)/A
0.00	0.007	0	0	0	0
0.20	0.007	60	84.300	2590.800	32.538
0.40	0.003	70	98.350	2580.600	38.111
0.60	0.038	89	125.045	2570.400	48.648
0.80	0.230	100	140.500	2560.200	54.879
1.00	0.340	106	148.930	2550.000	58.404
1.40	0.500	108	151.740	2529.600	59.986
1.80	0.565	95	133.475	2509.200	53.194
2.20	0.665	86	120.830	2488.800	48.550
2.60	0.710	83	116.615	2468.400	47.243
3.00	0.722	77	108.185	2448.000	44.193
3.40	0.728	73	102.565	2427.600	42.250
3.80	0.728	70	98.350	2407.200	40.857
4.20	0.728	67	94.135	2386.800	39.440

20kg		L_1	51	L_2	51
	Vertical	Proving	F=1.405	Corrected	
cumulative displ.	movement	ring	N/div	Area	Shear Stress
Mm(A*0.01)	(mm)	Reading		A' = L (L - δ)	(F x 1000)/A
0.00	0.002	0	0	0	0
0.20	0.003	115	161.575	2590.800	62.365
0.40	0.056	145	203.725	2580.600	78.945
0.60	0.105	150	210.750	2570.400	81.991
0.80	0.169	169	237.445	2560.200	92.745
1.00	0.269	173	243.065	2550.000	95.320
1.40	0.398	172	241.660	2529.600	95.533
1.80	0.528	166	233.230	2509.200	92.950
2.20	0.642	158	221.990	2488.800	89.196
2.60	0.697	152	213.560	2468.400	86.518
3.00	0.731	145	203.725	2448.000	83.221
3.40	0.710	140	196.700	2427.600	81.027
3.80	0.722	132	185.460	2407.200	77.044
4.20	0.772	124	174.220	2386.800	72.993
5.00	0.755	120	168.600	2346.000	71.867
5.50	0.738	120	168.600	2320.500	72.657

40kg		L_1	507	L_2	507
	Vertical	Proving	F=1.405	Corrected	
cumulative	movement	ring	N/div	Area	Shear Stress
displ.					
Mm(A*0.01)	(mm)	Reading		A' = L (L - δ)	(F x 1000)/A
0.00	-0.006	0	0	0	0
0.20	0.006	130	182.650	2590.800	70.499
0.40	0.039	190	266.950	2580.600	103.445
0.60	0.078	213	299.265	2570.400	116.427
0.80	0.168	239	335.795	2560.200	131.160
1.00	0.267	250	351.250	2550.000	137.745
1.40	0.426	251	352.655	2529.600	139.411
1.80	0.553	243	341.415	2509.200	136.065
2.20	0.666	233	327.365	2488.800	131.535
2.60	0.746	218	306.290	2468.400	124.084
3.00	0.792	209	293.645	2448.000	119.953
3.40	0.820	194	272.570	2427.600	112.280
3.80	0.826	177	248.685	2407.200	103.309
4.20	0.826	172	241.660	2386.800	101.249
5.00	0.826	170	238.850	2346.000	101.812
5.50	0.826	166	233.230	2320.500	100.509
6.00	0.826	168	236.040	2295.000	102.850



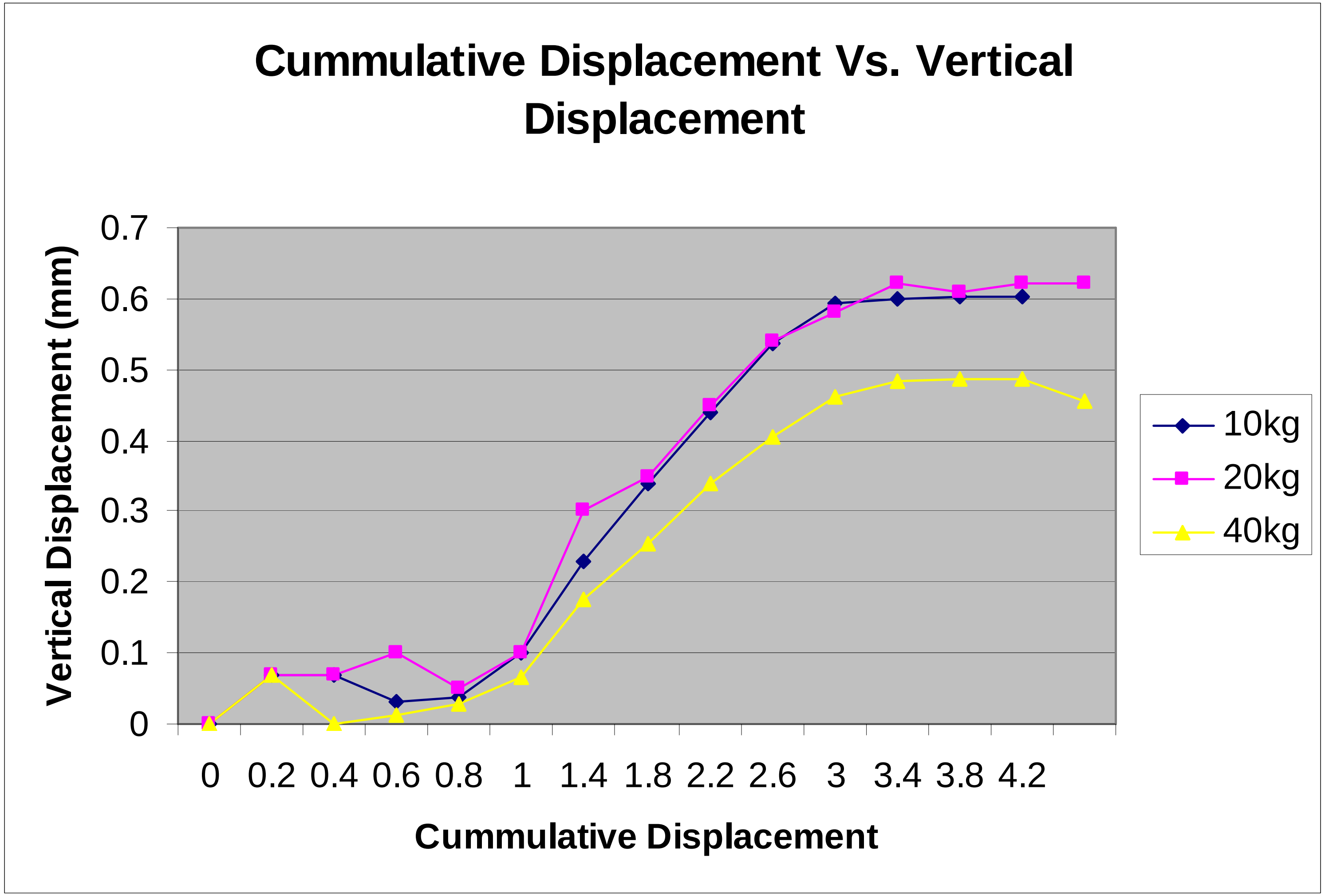
Appendix B : Standard Direct Shear Chart

Appendix B.9. Shear Box Test (Modified Compaction)

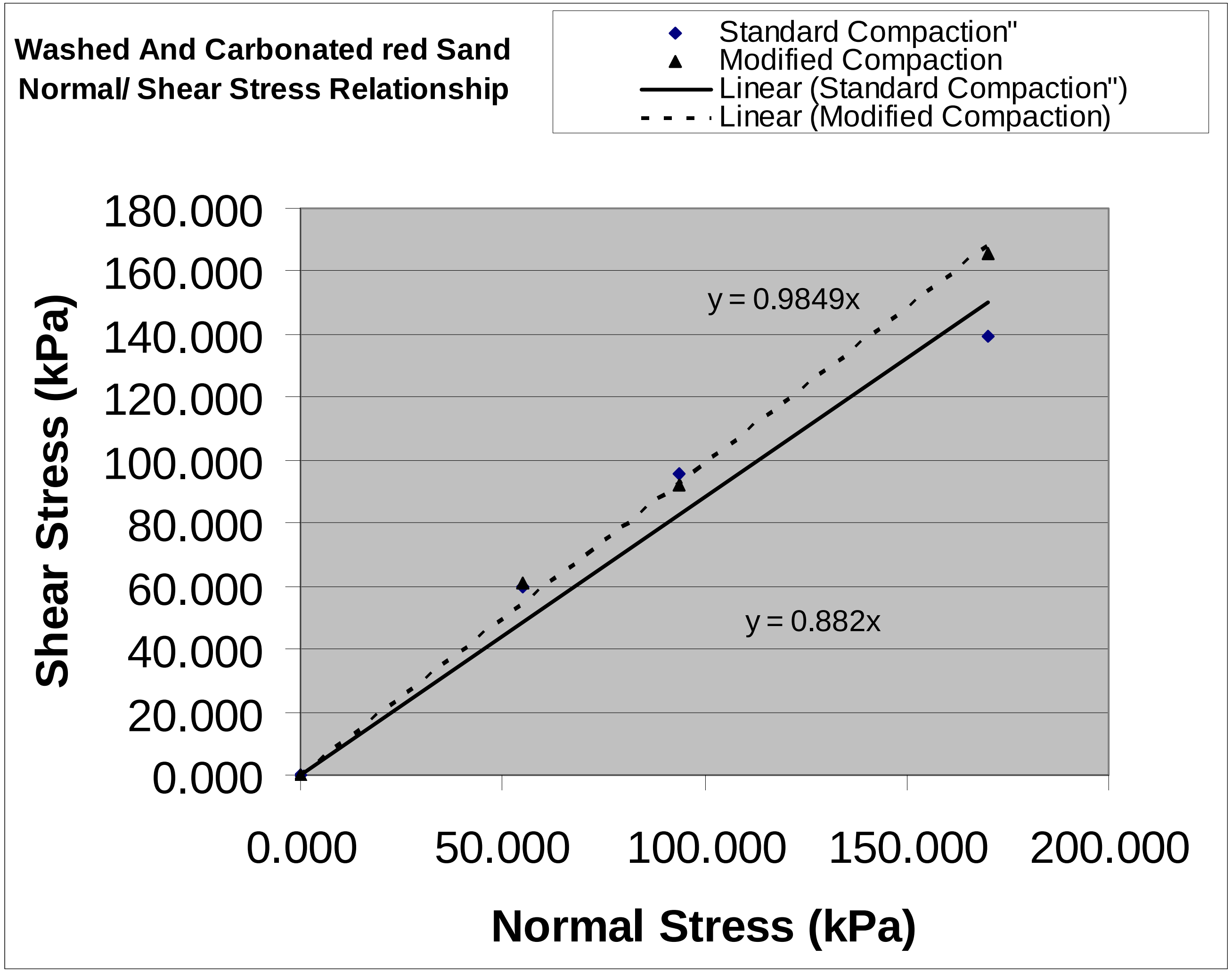
10kg		L_1	51	L_2	51
cumulative displ.	Vertical movement	Proving ring	F=1.405 N/div	Corrected Area	Shear Stress
Mm(A*0.01)	(mm)	Reading		A' = L (L - δ)	(F x 1000)/A
0.00	0.000	0	0	0	0
0.20	0.070	63	88.515	2590.800	34.165
0.40	0.070	76	106.780	2580.600	41.378
0.60	0.030	81	113.805	2570.400	44.275
0.80	0.038	95	133.475	2560.200	52.135
1.00	0.100	103	144.715	2550.000	56.751
1.40	0.230	107	150.335	2529.600	59.430
1.80	0.340	109	153.145	2509.200	61.033
2.20	0.440	107	150.335	2488.800	60.405
2.60	0.536	99	139.095	2468.400	56.350
3.00	0.594	87	122.235	2448.000	49.933
3.40	0.600	78	109.590	2427.600	45.143
3.80	0.602	73	102.565	2407.200	42.608
4.20	0.602	73	102.565	2386.800	42.972

20kg		L_1	51	L_2	51
cumulative displ.	Vertical movement	Proving ring	F=1.405 N/div	Corrected Area	Shear Stress
Mm(A*0.01)	(mm)	Reading		A' = L (L - δ)	(F x 1000)/A
0.00	0.000	0	0	0	0
0.20	0.000	102	143.310	2590.800	55.315
0.40	0.000	121	170.005	2580.600	65.878
0.60	0.001	139	195.295	2570.400	75.978
0.80	0.001	151	212.155	2560.200	82.867
1.00	0.001	157	220.585	2550.000	86.504
1.40	0.001	163	229.015	2529.600	90.534
1.80	0.001	164	230.420	2509.200	91.830
2.20	0.002	160	224.800	2488.800	90.325
2.60	0.002	150	210.750	2468.400	85.379
3.00	0.002	138	193.890	2448.000	79.203
3.40	0.002	132	185.460	2427.600	76.396
3.80	0.002	129	181.245	2407.200	75.293
4.20	0.002	125	175.625	2386.800	73.582
5.00	0.002	125	175.625	2346.000	74.861

40kg		L_1	507	L_2	507
cumulative displ. Mm(A*0.01)	Vertical movement (mm)	Proving ring Reading	F=1.405 N/div	Corrected Area A' = L (L - δ)	Shear Stress (F x 1000)/A
0.00	0.000	0	0	0	0
0.20	0.070	182	255.710	2590.800	98.699
0.40	0.000	220	309.100	2580.600	119.778
0.60	0.013	231	324.555	2570.400	126.266
0.80	0.028	255	358.275	2560.200	139.940
1.00	0.065	274	384.970	2550.000	150.969
1.40	0.176	282	396.210	2529.600	156.630
1.80	0.254	296	415.880	2509.200	165.742
2.20	0.338	293	411.665	2488.800	165.407
2.60	0.406	285	400.425	2468.400	162.220
3.00	0.460	264	370.920	2448.000	151.520
3.40	0.482	242	340.010	2427.600	140.060
3.80	0.486	220	309.100	2407.200	128.406
4.20	0.485	210	295.050	2386.800	123.617
5.00	0.456	213	299.265	2346.000	127.564



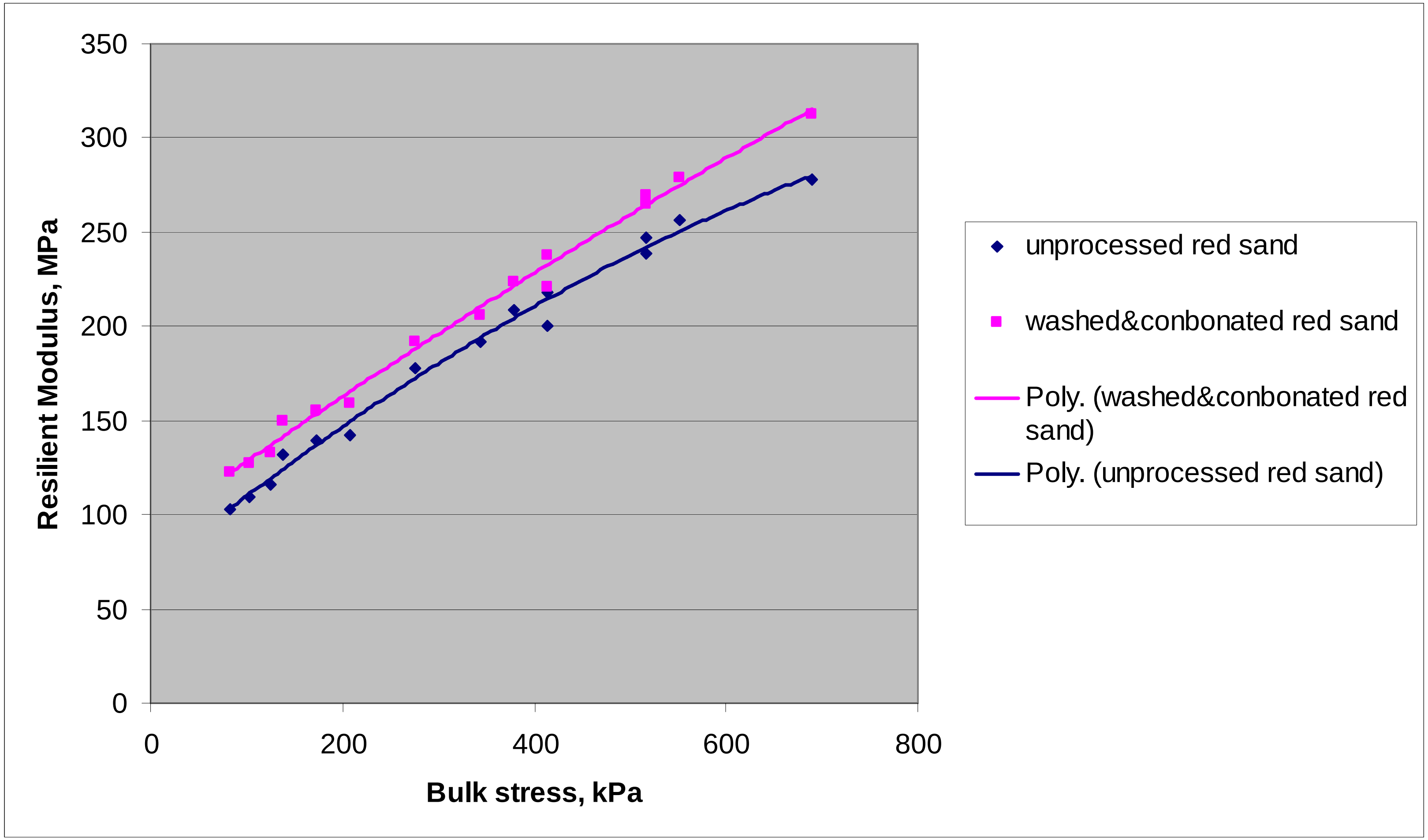
Appendix B: Modified Direct Shear Chart



Appendix B Strength Parameter Graph

Appendix B.10. Repeated Loading Triaxial Test

Sequence #	□□ Confining Pressure (kPa)	□d Applied Stress (kPa)	□1 Major principle Stress (kPa)	□1□□□ Bulk Stress(kPa)	**Unprocessed red sand Mr(MPa)**	**Washed &Carbonated Mr(Mpa)**
0	103.4	103.4	206.8	413.6	**212.19**	**230.56**
1	20.7	20.7	41.4	82.8	**102.90**	**122.59**
2	20.7	41.4	62.1	103.5	**109.62**	**127.23**
3	20.7	62.1	82.8	124.2	**115.77**	**132.76**
4	34.5	34.5	69	138	**131.78**	**150.05**
5	34.5	68.9	103.4	172.4	**139.49**	**155.70**
6	34.5	103.4	137.9	206.9	**142.14**	**159.53**
7	68.9	68.9	137.8	275.6	**177.34**	**191.70**
8	68.9	137.9	206.8	344.6	**192.14**	**205.60**
9	68.9	206.8	275.7	413.5	**200.65**	**221.04**
10	103.4	68.9	172.3	379.1	**208.93**	**223.46**
11	103.4	103.4	206.8	413.6	**218.23**	**238.09**
12	103.4	206.8	310.2	517	**238.43**	**264.49**
13	137.9	103.4	241.3	517.1	**246.66**	**269.08**
14	137.9	137.9	275.8	551.6	**256.26**	**279.21**
15	137.9	275.8	413.7	689.5	**277.84**	**312.24**



Appendix B :Repeated Load Triaxial Test

APPENDIX C

RED SAND STABILISATION

APPENDIX C-1

RED SAND PARTICLE SIZE DISTRIBUTION

Appendix C: Red Sand Stabilisation

Sample Location: Alcoa, Perth WA

Sample Number: A-01

Table C1: Sample A-01 data

Total Mass of Air Dried Sample (g):	900
Dry Mass of Sample pre washing (g):	594.64
Dry Mass of Sample After Washing (g):	560.9
Loss of Mass through Washing (g):	33.7
Total % Passing 0.075mm Sieve:	5.7

Sieve Analysis

Table C2: Particle Size Distribution

Sieve Opening (mm)	Wt. Sieve (gm)	Wt. Sieve + Soil (gm)	Soil Retained (gm)	Cumulative Retained (gm)	Cumulative Soil Retained (%)	Percent Soil Passing (%)
4.75	479.75	479.75	0.00	0.00	0.00	100.00
2.36	481.40	481.40	0.00	0.00	0.00	100.00
1.18	389.46	390.95	1.49	1.49	0.25	99.75
0.60	359.34	414.44	55.10	56.59	9.52	90.48
0.43	383.46	465.85	82.39	138.98	23.37	76.63
0.30	316.14	451.20	135.06	274.04	46.09	53.91
0.150	302.09	549.40	247.31	521.35	87.67	12.33
0.075	336.02	375.60	39.58	560.93	94.33	5.67
Pan	262.10	263.00	0.90	561.83	94.48	5.52

Appendix C: Red Sand Stabilisation

Sample Location: Alcoa, Perth WA

Sample Number: A-02

Table C3: Sample A-02 data

Total Mass of Air Dried Sample (g):	900
Dry Mass of Sample pre washing (g):	584.36
Dry Mass of Sample After Washing (g):	552.8
Loss of Mass through Washing (g):	31.56
Total % Passing 0.075mm Sieve:	5.40

Sieve Analysis

Table C4: Particle Size Distribution

Sieve Opening (mm)	Wt. Sieve (gm)	Wt. Sieve + Soil (gm)	Soil Retained (gm)	Cumulative Soil Retained (gm)	Cumulative Soil Retained (%)	Percent Soil Passing (%)
4.75	479.75	479.75	0.00	0.00	0.00	100.00
2.36	481.40	483.96	2.56	2.56	0.44	99.56
1.18	389.46	392.65	3.19	5.75	0.98	99.02
0.60	359.34	426.10	66.76	72.51	12.41	87.59
0.43	383.46	470.88	87.42	159.94	27.37	72.63
0.30	316.14	449.88	133.74	293.67	50.26	49.74
0.150	302.09	526.56	224.47	518.14	88.67	11.33
0.075	336.02	370.64	34.62	552.76	94.59	5.41
Pan	262.10	284.93	22.83	575.59	98.50	1.50

Sample Location: Alcoa, Perth WA

Sample Number: A-03

Table C5: Sample A-03 data

Total Mass of Air Dried Sample (g):	900
Dry Mass of Sample pre washing (g):	603.96
Dry Mass of Sample After Washing (g):	574.5
Loss of Mass through Washing (g):	29.46
Total % Passing 0.075mm Sieve:	4.88

Sieve Analysis

Table C6: Particle Size Distribution

Sieve Opening (mm)	Wt. Sieve (gm)	Wt. Sieve + Soil (gm)	Soil Retained (gm)	Cumulative Soil Retained (gm)	Cumulative Soil Retained (%)	Percent Soil Passing (%)
4.75	479.75	481.18	1.43	1.43	0.24	99.76
2.36	481.40	483.37	1.97	3.41	0.56	99.44
1.18	389.46	392.93	3.47	6.87	1.14	98.86
0.60	359.34	445.16	85.82	92.69	15.35	84.65
0.43	383.46	477.33	93.87	186.56	30.89	69.11
0.30	316.14	455.21	139.07	325.63	53.92	46.08
0.150	302.09	515.31	213.22	538.85	89.22	10.78
0.075	336.02	371.63	35.61	574.46	95.12	4.88
Pan	262.10	277.28	15.18	589.65	97.63	2.37

Sample Location: Alcoa, Perth WA

Sample Number: A-04

Table C7: Sample A-04 data

Total Mass of Air Dried Sample (g):	900
Dry Mass of Sample pre washing (g):	534.68
Dry Mass of Sample After Washing (g):	511.6
Loss of Mass through Washing (g):	23.08
Total % Passing 0.075mm Sieve:	4.32

Sieve Analysis

Table C8: Particle Size Distribution

Sieve Opening (mm)	Wt. Sieve (gm)	Wt. Sieve + Soil (gm)	Soil Retained (gm)	Cumulative Soil Retained (gm)	Cumulative Soil Retained (%)	Percent Soil Passing (%)
4.75	479.75	481.15	1.40	1.40	0.26	99.74
2.36	481.40	482.00	0.60	2.00	0.37	99.63
1.18	389.46	392.81	3.35	5.35	1.00	99.00
0.60	359.34	454.34	95.00	100.35	18.77	81.23
0.43	383.46	472.11	88.65	189.00	35.35	64.65
0.30	316.14	434.09	117.95	306.95	57.41	42.59
0.150	302.09	478.31	176.22	483.17	90.37	9.63
0.075	336.02	364.44	28.42	511.59	95.68	4.32
Pan	262.10	281.82	19.72	531.31	99.37	0.63

Sample Location: Alcoa, Perth WA

Sample Number: A-05

Table C9: Sample A-05 data

Total Mass of Air Dried Sample (g):	900
Dry Mass of Sample pre washing (g):	606.90
Dry Mass of Sample After Washing (g):	585.11
Loss of Mass through Washing (g):	21.8
Total % Passing 0.075mm Sieve:	3.60

Sieve Analysis

Table C10: Particle Size Distribution

Sieve Opening (mm)	Wt. Sieve (gm)	Wt. Sieve + Soil (gm)	Soil Retained (gm)	Cumulative Soil Retained (gm)	Cumulative Soil Retained (%)	Percent Soil Passing (%)
4.75	479.75	482.41	2.66	2.66	0.44	99.56
2.36	481.40	482.97	1.57	4.24	0.70	99.30
1.18	389.46	393.41	3.95	8.18	1.35	98.65
0.60	359.34	461.06	101.72	109.90	18.11	81.89
0.43	383.46	483.58	100.12	210.02	34.61	65.39
0.30	316.14	453.57	137.43	347.46	57.25	42.75
0.150	302.09	507.51	205.42	552.88	91.10	8.90
0.075	336.02	368.25	32.23	585.11	96.41	3.59
Pan	262.10	275.22	13.12	598.22	98.57	1.43

APPENDIX C-2

CRUSHED ROCK PARTICLE SIZE DISTRIBUTION

Appendix C: Red Sand Stabilisation

Sample Location: Readymix Gosnells Quarry, Perth WA

Table C-2-1: Sample data

Total Mass of Air Dried Sample (g):	1000
Dry Mass of Sample pre washing (g):	758.82
Dry Mass of Sample After Washing (g):	720.8
Loss of Mass through Washing (g):	38.0
Total % Passing 0.075mm Sieve:	5.01

Sieve Analysis

Table C-2-2: Particle Size Distribution

Sieve Opening (mm)	Wt. Sieve (gm)	Wt. Sieve + Soil (gm)	Soil Retained (gm)	Cumulative Soil Retained (gm)	Cumulative Soil Retained (%)	Percent Soil Passing (%)
26.5	564.28	564.28	0	0	0.00	100.00
19	540.55	549.9	9.35	9.35	1.23	98.77
13.2	608.3	703.35	95.05	104.4	13.76	86.24
9.5	542.25	616.85	74.6	179	23.59	76.41
4.75	479.4	618.05	138.65	317.65	41.86	58.14
2.36	481.20	590.10	108.9	426.55	56.21	43.79
1.18	389.20	499.80	110.6	537.15	70.79	29.21
0.60	359.22	433.79	74.57	611.72	80.61	19.39
0.43	383.34	409.30	25.96	637.68	84.04	15.96
0.30	316.08	340.50	24.42	662.1	87.25	12.75
0.150	302.84	343.90	41.06	703.16	92.66	7.34
0.075	335.88	353.54	17.66	720.82	94.99	5.01
Pan	261.98	265.98	4	724.82	95.52	4.48

APPENDIX C-3

FLY ASH PARTICLE SIZE DISTRIBUTION

MASTERSIZER

FLYASH AUSTRALIA REPORT

Custom Histogram Table

ID: Cockburn GP Cement | Run No: 1 | Measured: 28/4/2004 11:03AM
File: COLLIE | Rec. No: 103 | Analysed: 28/4/2004 11:03AM
Path: C:\SIZERMP\DATA\ | Source: Analysed

Sampler: Internal | Measured Beam Obscuration: 12.8 %
Presentation: 5_ASH | Analysis: Polydisperse | Residual: 0.762 %
Modifications: None

Conc. = 0.0095 %Vol | Density=1.000 g/cm^3 | SSA.= 37042.4cm^2/cm^3
Distribution: Volume | D[4, 3] = 16.61 um | D[3, 2] = 1.62 um
D(v, 0.1) = 0.42 um | D(v, 0.5) = 12.22 um | D(v, 0.9) = 40.70 um
Span = 3.296E+00 | **% Under 45um= 92.47%**

Low (um)	Volume In%	High (um)	% Under	Low (um)	Volume In%	High (um)	% Under
0.05	0.00	0.06	0.00	60.00	0.99	65.00	98.68
0.06	22.18	1.00	22.18	65.00	0.82	70.00	99.50
1.00	3.80	2.00	25.98	70.00	0.46	75.00	99.96
2.00	2.60	3.00	28.58	75.00	0.04	80.00	100.00
3.00	2.44	4.00	31.02	80.00	0.00	85.00	100.00
4.00	2.48	5.00	33.50	85.00	0.00	90.00	100.00
5.00	6.02	7.50	39.52	90.00	0.00	100.00	100.00
7.50	5.67	10.00	45.19	100.00	0.00	110.00	100.00
10.00	10.58	15.00	55.77	110.00	0.00	120.00	100.00
15.00	9.66	20.00	65.44	120.00	0.00	130.00	100.00
20.00	8.32	25.00	73.76	130.00	0.00	140.00	100.00
25.00	6.71	30.00	80.47	140.00	0.00	150.00	100.00
30.00	5.19	35.00	85.66	150.00	0.00	160.00	100.00
35.00	3.88	40.00	89.54	160.00	0.00	170.00	100.00
40.00	2.93	45.00	92.47	170.00	0.00	180.00	100.00
45.00	2.24	50.00	94.71	180.00	0.00	190.00	100.00
50.00	1.71	55.00	96.42	190.00	0.00	200.00	100.00
55.00	1.26	60.00	97.68	200.00	0.00	250.00	100.00

APPENDIX C-4

RED SAND MODIFIED COMPACTION TEST

Red Sand 90%, Fly Ash 10%

Table C-4-1: Compaction Data

		Trial #			
		1	2	3	4
Assumed Water Content	%	5	10	15	20
Weight of Dry Soil Use	g	3500	3500	3500	3500
Weight of Dry Fly Ash in Use	g	389	389	389	389
Amount of Water Added	g	194	389	583	778
Weight of Wet Soil + Mould	g	5771	5936	5985	5996
Weight of Mould	g	3889	3889	3889	3889
Weight of Wet Soil + Mould	g	1882	2047	2096	2107
Wet Density	g/cm^3	1.88	2.05	2.09	2.11
Dry Soil Density	g/cm^3	**1.881**	**2.046**	**2.095**	**2.106**

Table C-4-2: Moisture Content

		Trial #			
		1	2	3	4
Container	#	A1	A2	A3	A4
Weight of Wet Soil + Container	g	76.55	71.12	74.90	89.74
Weight of Dry Soil + Container	g	73.27	65.88	68.28	78.96
Weight of Water	g	3.28	5.24	6.62	10.78
Weight of Container	g	23.26	19.26	19.03	18.25
Weight of Dry Soil	g	50.01	46.62	49.25	60.71
Actual Water Content	%	**6.56**	**11.24**	**13.44**	**17.76**

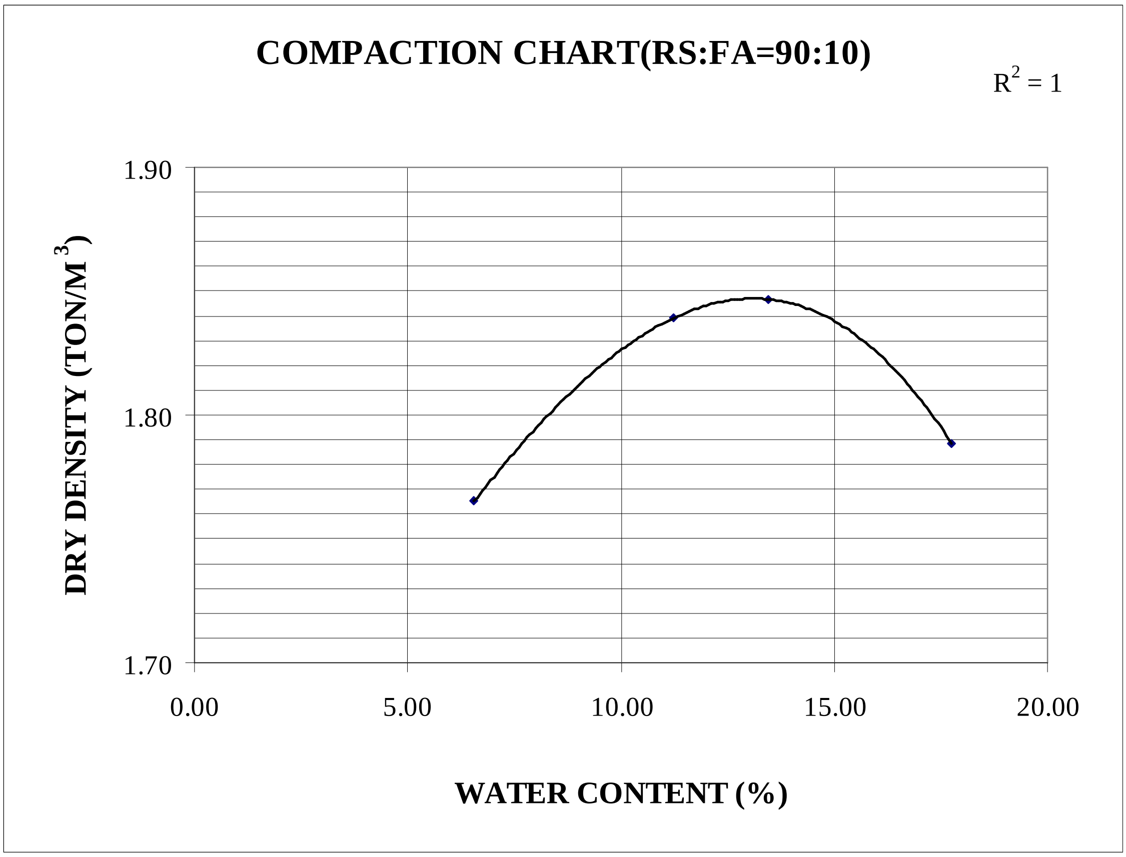


Figure C-4-1: Compaction Curve RS90%, FA10%

Red Sand 80%, Fly Ash 20%

Table C-4-3: Compaction Data

		Trial #			
		1	2	3	4
Assumed Water Content	%	5	10	15	20
Weight of Dry Soil Use	g	3500	3500	3500	3500
Weight of Dry Fly Ash in Use	%	875	875	875	875
Amount of Water Added	g	219	438	656	875
Weight of Wet Soil + Mould	g	5804	6062	6023	5994
Weight of Mould	g	3889	3889	3889	3889
Weight of Wet Soil	g	1915	2173	2134	2105
Wet Density	g/cm^3	1.91	2.17	2.13	2.10
Dry Soil Density	g/cm^3	**1.823**	**1.982**	**1.868**	**1.767**

Table C-4-4: Moisture Content

		Trial #			
		1	2	3	4
Container	#	A1	A2	A3	A4
Weight of Wet Soil + Container	g	91.49	92.61	128.12	136.06
Weight of Dry Soil + Container	g	88.23	86.2	114.56	117.19
Weight of Water	g	3.26	6.41	13.56	18.87
Weight of Container	g	23.26	19.26	19.03	18.25
Weight of Dry Soil	g	64.97	66.94	95.53	98.94
Actual Water Content	%	**5.02**	**9.58**	**14.19**	**19.07**

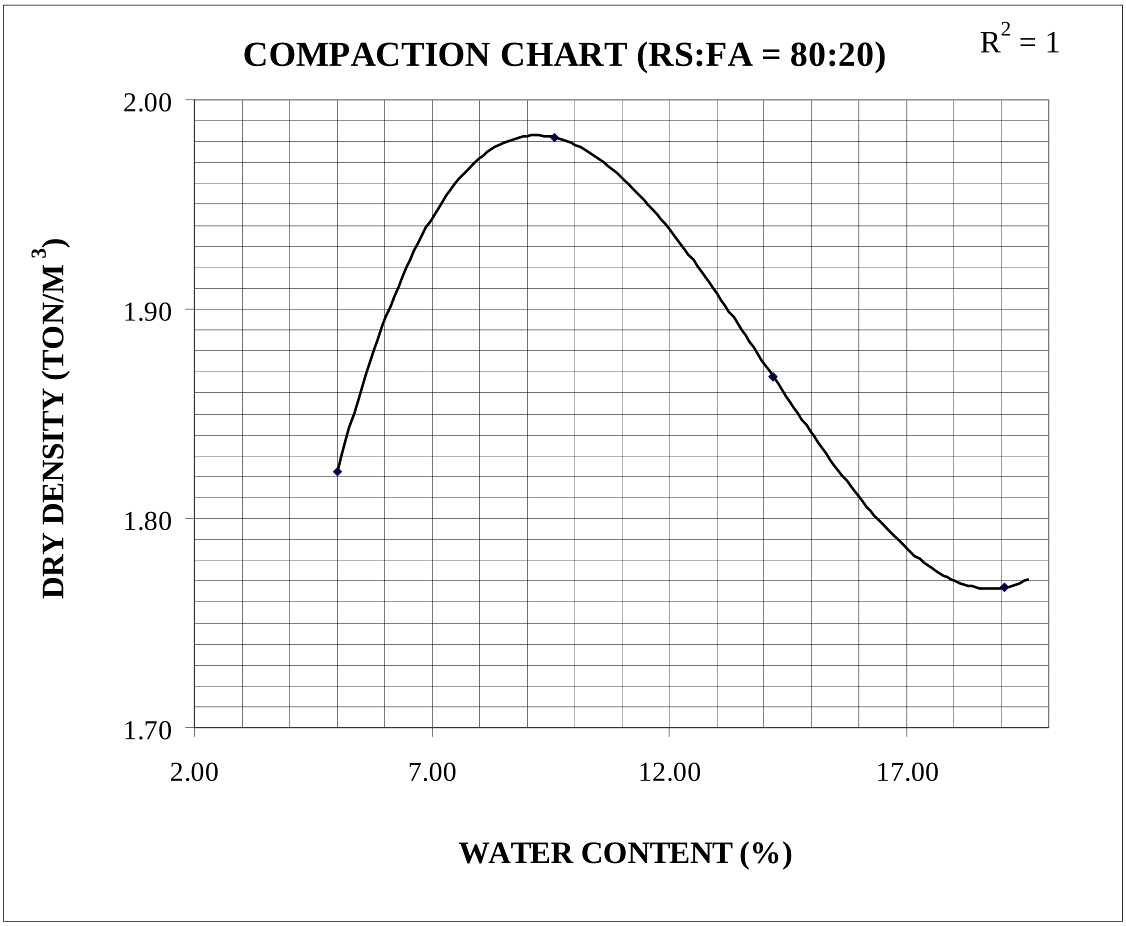


Figure C-4-2: Compaction Curve RS80%, FA20%

Red Sand 70%, Fly Ash 30%

Table C-4-5: Compaction Data

		Trial #			
		1	2	3	4
Assumed Water Content	%	6	8	10	12
Weight of Dry Soil Use	g	3000	3000	3000	3000
Weight of Dry Fly Ash in Use	g	1286	1286	1286	1286
Amount of Water Added	g	257	343	429	514
Weight of Wet Soil + Mould	g	5877	6014	6076	6014
Weight of Mould	g	3889	3889	3889	3889
Weight of Wet Soil	g	1988	2125	2187	2125
Wet Density	g/cm^3	1.99	2.12	2.19	2.12
Dry Soil Density	g/cm^3	**1.469**	**1.491**	**1.481**	**1.220**

Table C-4-6: Moisture Content

		Trial #			
		1	2	3	4
Container	#	A1	A2	A3	A4
Weight of Wet Soil + Container	g	60.74	65.13	71.35	101.39
Weight of Dry Soil + Container	g	58.49	61.67	66.59	92.36
Weight of Water	g	2.25	3.46	4.76	9.03
Weight of Container	g	23.26	19.26	19.03	18.25
Weight of Dry Soil	g	35.23	42.41	47.56	74.11
Actual Water Content	%	**6.39**	**8.16**	**10.01**	**12.18**

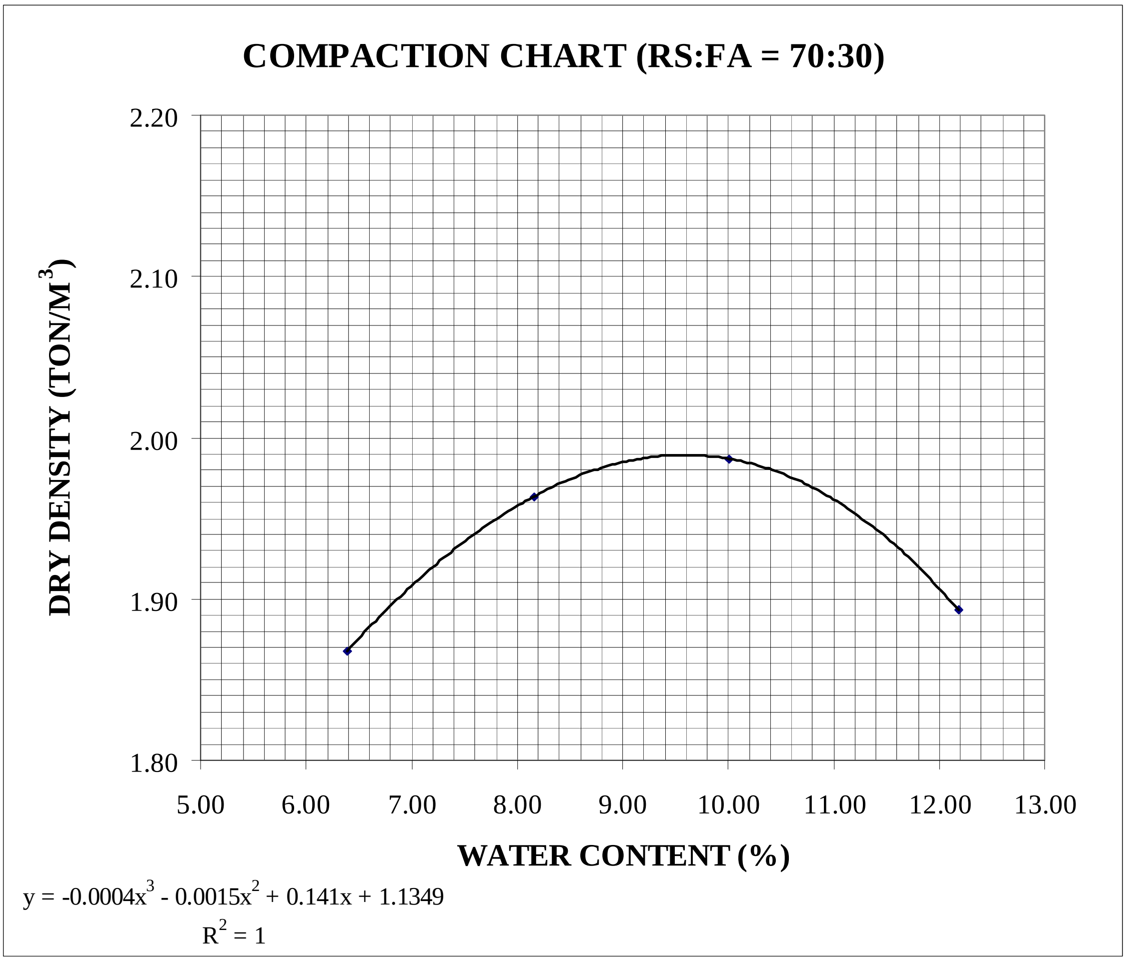


Figure C-4-3: Compaction Curve RS70%, FA30%

Red Sand 60%, Fly Ash 40%

Table C-4-7: Compaction Data

		Trial #					
		1	2	3	4	5	6
Assumed Water Content	%	3	5	7	9	11	13
Weight of Dry Soil Use	g	2800	2800	2800	2800	2800	2800
Weight of Dry Fly Ash in Use	g	1867	1867	1867	1867	1867	1867
Amount of Water Added	g	140	233	327	420	513	607
Weight of Wet Soil + Mould	g	5792	5865	5968	6035	6011	5961
Weight of Mould	g	3889	3889	3889	3889	3889	3889
Weight of Wet Soil	g	1903	1976	2079	2146	2122	2072
Wet Density	g/cm^3	1.90	1.97	2.08	2.14	2.12	2.07
Dry Soil Density	g/cm^3	**1.836**	**1.872**	**1.933**	**1.965**	**1.904**	**1.827**

Table C-4-8: Moisture Content

		Trial #					
		1	2	3	4	5	6
Container	#	A1	A2	A3	A4	A5	A6
Weight of Wet Soil + Container	g	64.32	83.84	74.39	78.84	98.36	141.90
Weight of Dry Soil + Container	g	62.9	80.47	70.52	73.76	90.24	127.33
Weight of Water	g	1.42	3.37	3.87	5.08	8.12	14.57
Weight of Container	g	23.26	19.26	19.03	18.25	19.14	18.25
Weight of Dry Soil	g	39.64	61.21	51.49	55.51	71.1	109.08
Actual Water Content	%	**3.58**	**5.51**	**7.52**	**9.15**	**11.42**	**13.36**

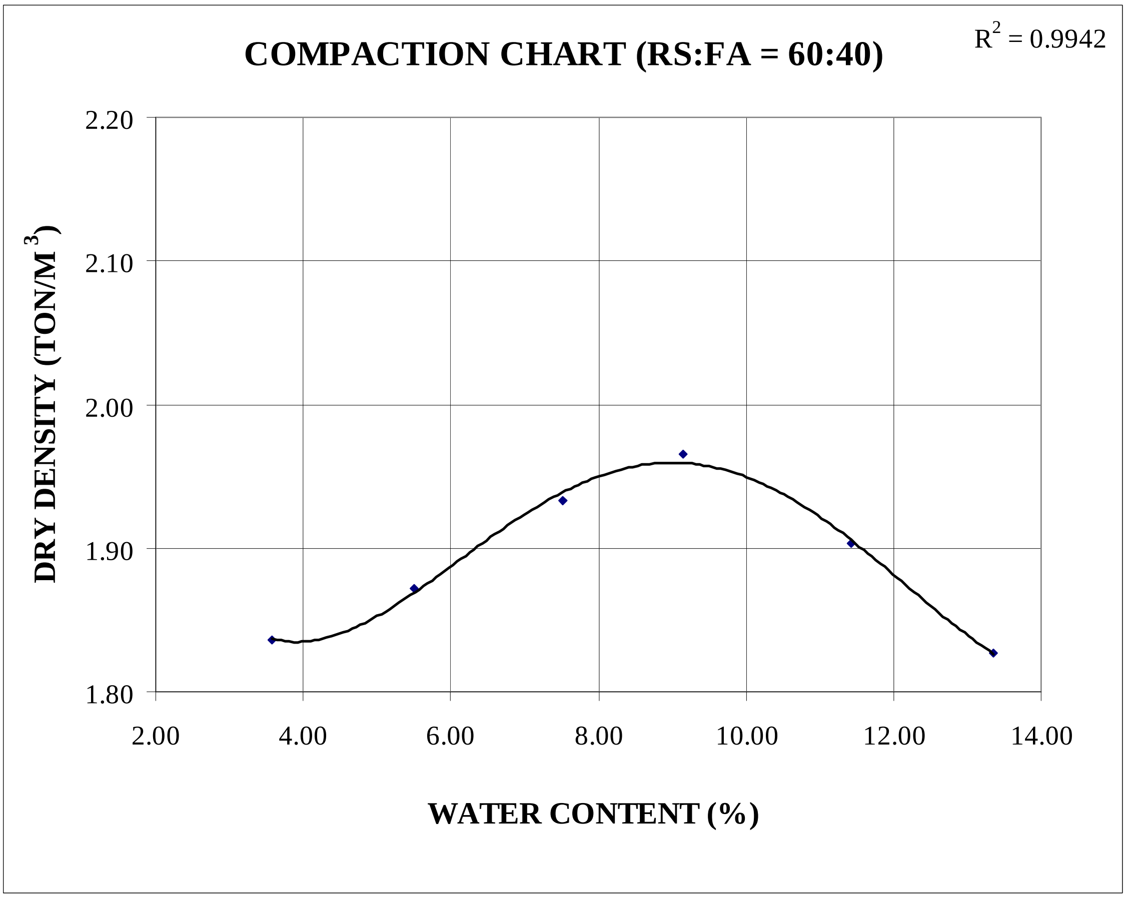


Figure C-4-4: Compaction Curve RS60%, FA40%

Red Sand 50%, Fly Ash 50%

Table C-4-9: Compaction Data

		Trial #					
		1	2	3	4	5	6
Assumed Water Content	%	3	5	7	9	11	13
Weight of Dry Soil Use	g	1700	1700	1700	1700	1700	1700
Weight of Dry Fly Ash in Use	g	1700	1700	1700	1700	1700	1700
Amount of Water Added	g	102	170	238	306	374	442
Weight of Wet Soil + Mould	g	5747	5830	5915	6002	5989	5944
Weight of Mould	g	3889	3889	3889	3889	3889	3889
Weight of Wet Soil	g	1858	1941	2026	2113	2100	2055
Wet Density	g/cm^3	1.86	1.94	2.02	2.11	2.10	2.05
Dry Soil Density	g/cm^3	**1.238**	**1.411**	**1.358**	**1.513**	**1.241**	**1.127**

Table C-4-10: Moisture Content

		Trial #					
		1	2	3	4	5	6
Container	#	A1	A2	A3	A4	A5	A6
Weight of Wet Soil + Container	g	75.53	59.09	72.02	61.55	96.39	111.38
Weight of Dry Soil + Container	g	73.3	56.77	68.09	57.84	88.32	100.46
Weight of Water	g	2.23	2.32	3.93	3.71	8.07	10.92
Weight of Container	g	23.26	19.26	19.03	18.25	19.14	18.25
Weight of Dry Soil	g	50.04	37.51	49.06	39.59	69.18	82.21
Water Content	%	**4.46**	**6.19**	**8.01**	**9.37**	**11.67**	**13.28**

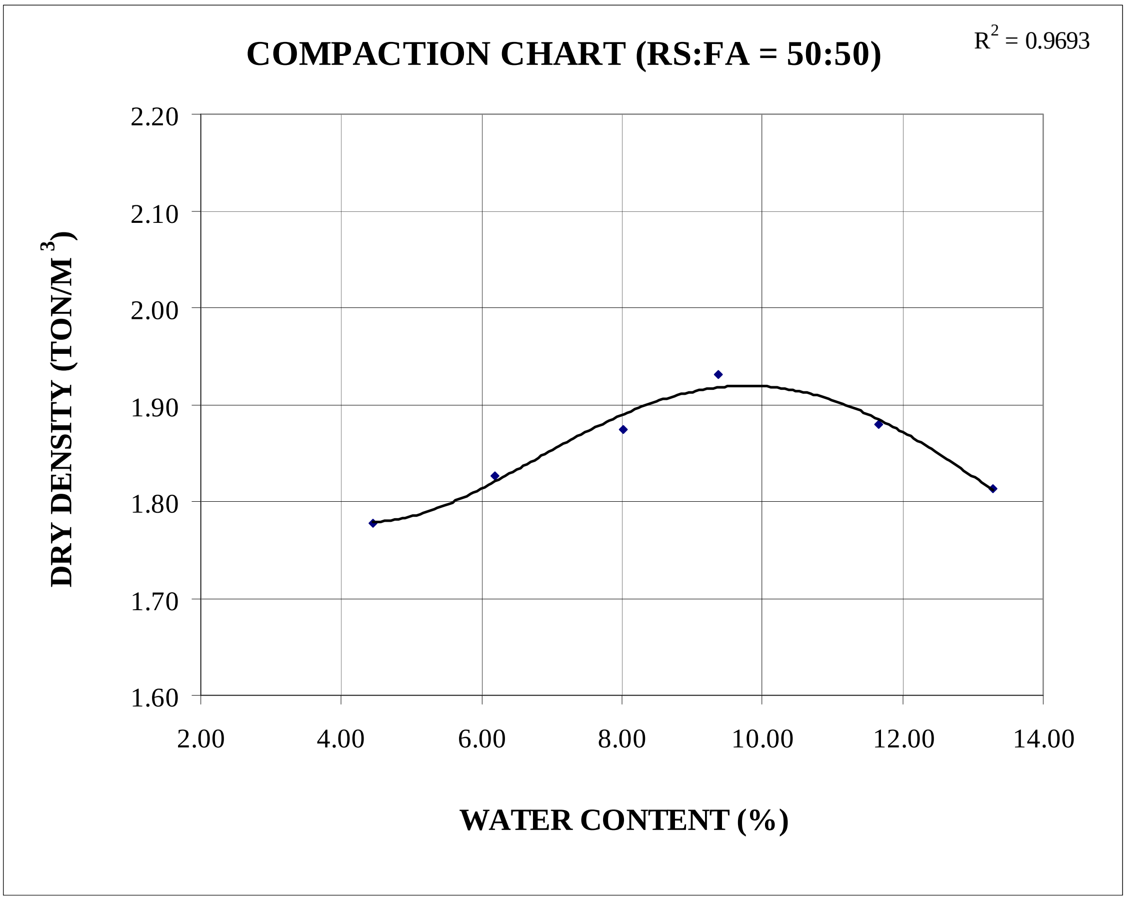


Figure C-4-5: Compaction Curve RS50%, FA50%

APPENDIX C-5

CRUSHED ROCK MODIFIED COMPACTION TEST

Appendix C: Red Sand Stabilisation

Table C-5-1: Compaction Data

DENSITY		Trial #			
		1	2	3	4
Assumed Water Content	%	3	6	9	12
Mass of Dry Soil	g	2885	2629	2807	2833
Amount of Water Added	g	57.7	157.4	252.63	339.96
Weight of Wet Soil + Mould	g	6751	6955	6977	6986
Weight of Mould	g	4532	4532	4532	4532
Weight of Wet Soil	g	2219	2423	2445	2454
Wet Density	g/cm^3	2.22	2.42	2.44	2.45
Dry Soil Density	g/cm^3	**2.151**	**2.288**	**2.272**	**2.270**

Table C-5-2: Moisture Content

MOISTURE CONTENT		Trial #			
		1	2	3	4
Container	#	A1	2	A3	4
Weight of Wet Soil + Container	g	378.2	385.84	487.9	512.2
Weight of Dry Soil + Container	g	368.54	367.72	457.3	477.9
Weight of Water	g	9.66	18.12	30.6	34.3
Weight of Container	g	56.25	58.06	53.51	51.00
Weight of Dry Soil	g	312.29	309.66	403.79	426.9
Actual Water Content	%	**3.09**	**5.85**	**7.58**	**8.03**

APPENDIX C-6
RED SAND UNCONFINED COMPRESSIVE STRENGTH

Appendix C: Red Sand Stabilisation

Samples with 3 day curing

Table C-6-1: Preparation of Mixtures

<table>
<tr><th rowspan="2">Sample Name</th><th rowspan="2">The ratio of Lime: Fly Ash</th><th rowspan="2">Total mass
(g)</th><th colspan="3">The ratio of RS:FA:LD</th><th rowspan="2">Added water (OMC=9.6 %)</th></tr>
<tr><th>RS</th><th>FA</th><th>LKD</th></tr>
<tr><td rowspan="3">RSFALKD-1</td><td rowspan="3">LD-1:FA-1</td><td rowspan="3">2200</td><td>70</td><td>15</td><td>15</td><td rowspan="3">211.2</td></tr>
<tr><td colspan="3">The weight of each mixture(g)</td></tr>
<tr><td>1540</td><td>330</td><td>330</td></tr>
<tr><td rowspan="3">RSFALKD-2</td><td rowspan="3">LD-1:FA-2</td><td rowspan="3">2200</td><td>70</td><td>20</td><td>10</td><td rowspan="3">211.2</td></tr>
<tr><td colspan="3">The weight of each mixture(g)</td></tr>
<tr><td>1540</td><td>440</td><td>220</td></tr>
<tr><td rowspan="3">RSFALKD-3</td><td rowspan="3">LD-1:FA-3</td><td rowspan="3">2200</td><td>70</td><td>22.5</td><td>7.5</td><td rowspan="3">211.2</td></tr>
<tr><td colspan="3">The weight of each mixture(g)</td></tr>
<tr><td>1540</td><td>495</td><td>165</td></tr>
<tr><td rowspan="3">RSFALKD-4</td><td rowspan="3">LD-1:FA-4</td><td rowspan="3">2200</td><td>70</td><td>24</td><td>6</td><td rowspan="3">211.2</td></tr>
<tr><td colspan="3">The weight of each mixture(g)</td></tr>
<tr><td>1540</td><td>528</td><td>132</td></tr>
<tr><td rowspan="3">RSFALKD-5</td><td rowspan="3">LD-1:FA-5</td><td rowspan="3">2200</td><td>70</td><td>25</td><td>5</td><td rowspan="3">211.2</td></tr>
<tr><td colspan="3">The weight of each mixture(g)</td></tr>
<tr><td>1540</td><td>550</td><td>110</td></tr>
</table>

Table C-6-2: Molding of Specimens

Sample Name	The ratio of Lime: Fly Ash	Wt. Mold	Wt. Mold & Mixtures	Wt. Compacted Mixture	Re-weight Sample (g)
RSFALKD-1	LD-1:FA-1	2018.00	3956.00	1938.00	1932.00
RSFALKD-2	LD-1:FA-2	2018.00	4041.00	2023.00	2017.00
RSFALKD-3	LD-1:FA-3	2018.00	4080.00	2062.00	2056.00
RSFALKD-4	LD-1:FA-4	2018.00	4100.00	2082.00	2075.00
RSFALKD-5	LD-1:FA-5	2018.00	4119.00	2101.00	2097.00

Table C-6-3: Moisture Content

Sample Name	Wt. Container	Wt. Container & Wet mixtures	Wt. Container & Dry mixtures	Water Content (%)
RSFALKD-1	22.88	82.40	76.92	***10.14***
RSFALKD-2	19.57	70.65	66.07	***9.85***
RSFALKD-3	23.96	95.74	89.45	***9.60***
RSFALKD-4	23.10	86.85	81.32	***9.50***
RSFALKD-5	24.06	98.20	91.73	***9.56***

Table C-6-4: UCS Testing

Sample Name	**The ratio of Lime: Fly Ash**	**Age of specimens (Days)**	**Weight before Testing (g)**	**Max. Compressive Loads (kN)**	**UCS strength (kPa)**
RSFALKD-1	LD-1:FA-1	3	1924.00	2.38	***303.18***
RSFALKD-2	LD-1:FA-2	3	2007.00	3.60	***458.60***
RSFALKD-3	LD-1:FA-3	3	2050.00	3.74	***476.43***
RSFALKD-4	LD-1:FA-4	3	2066.00	3.81	***485.35***
RSFALKD-5	LD-1:FA-5	3	2079.00	4.68	***596.18***

Appendix C: Red Sand Stabilisation

Samples with 7 day curing

Table C-6-5: Preparation of Mixtures

<table>
<tr><th rowspan="2">Sample Name</th><th rowspan="2">The ratio of Lime: Fly Ash</th><th rowspan="2">Total mass
(g)</th><th colspan="3">The ratio of RS:FA:LD</th><th rowspan="2">Added water (OMC=9.6 %)</th></tr>
<tr><th>RS</th><th>FA</th><th>LKD</th></tr>
<tr><td rowspan="3">RSFALKD-1</td><td rowspan="3">LD-1:FA-1</td><td rowspan="3">2200</td><td>70</td><td>15</td><td>15</td><td rowspan="3">211.2</td></tr>
<tr><td colspan="3">The weight of each mixture(g)</td></tr>
<tr><td>1540</td><td>330</td><td>330</td></tr>
<tr><td rowspan="3">RSFALKD-2</td><td rowspan="3">LD-1:FA-2</td><td rowspan="3">2200</td><td>70</td><td>20</td><td>10</td><td rowspan="3">211.2</td></tr>
<tr><td colspan="3">The weight of each mixture(g)</td></tr>
<tr><td>1540</td><td>440</td><td>220</td></tr>
<tr><td rowspan="3">RSFALKD-3</td><td rowspan="3">LD-1:FA-3</td><td rowspan="3">2200</td><td>70</td><td>22.5</td><td>7.5</td><td rowspan="3">211.2</td></tr>
<tr><td colspan="3">The weight of each mixture(g)</td></tr>
<tr><td>1540</td><td>495</td><td>165</td></tr>
<tr><td rowspan="3">RSFALKD-4</td><td rowspan="3">LD-1:FA-4</td><td rowspan="3">2200</td><td>70</td><td>24</td><td>6</td><td rowspan="3">211.2</td></tr>
<tr><td colspan="3">The weight of each mixture(g)</td></tr>
<tr><td>1540</td><td>528</td><td>132</td></tr>
<tr><td rowspan="3">RSFALKD-5</td><td rowspan="3">LD-1:FA-5</td><td rowspan="3">2200</td><td>70</td><td>25</td><td>5</td><td rowspan="3">211.2</td></tr>
<tr><td colspan="3">The weight of each mixture(g)</td></tr>
<tr><td>1540</td><td>550</td><td>110</td></tr>
</table>

Table C-6-6: Molding of Specimens

Sample Name	The ratio of Lime: Fly Ash	Wt. Mold	Wt. Mold & mixtures	Wt. Compacted Mixture	Re-weight Sample (g)
RSFALKD-1	LD-1:FA-1	2018.00	3952.00	1934.00	1932.00
RSFALKD-2	LD-1:FA-2	2018.00	4050.00	2032.00	2017.00
RSFALKD-3	LD-1:FA-3	2018.00	4102.00	2084.00	2056.00
RSFALKD-4	LD-1:FA-4	2018.00	4126.00	2108.00	2075.00
RSFALKD-5	LD-1:FA-5	2018.00	4139.00	2121.00	2097.00

Table C-6-7: Moisture Content

Sample Name	Wt. Container	Wt. Container & wet mixtures	Wt. Container & dry mixtures	Water Content (%)
RSFALKD-1	22.88	86.13	80.17	***10.40***
RSFALKD-2	19.57	65.03	60.93	***9.91***
RSFALKD-3	23.96	96.68	90.15	***9.87***
RSFALKD-4	23.10	96.99	90.35	***9.87***
RSFALKD-5	24.06	98.23	91.55	***9.90***

Table C-6-8: UCS Testing

Sample Name	**The ratio of Lime: Fly Ash**	**Age of specimens (Days)**	**Weight before Testing (g)**	**Max. Compressive Loads (kN)**	**UCS strength (kPa)**
RSFALKD-1	LD-1:FA-1	7	1906.00	3.14	***400.00***
RSFALKD-2	LD-1:FA-2	7	2008.00	4.24	***540.13***
RSFALKD-3	LD-1:FA-3	7	2064.00	4.53	***577.07***
RSFALKD-4	LD-1:FA-4	7	2088.00	5.11	***650.96***
RSFALKD-5	LD-1:FA-5	7	2098.00	5.78	***736.31***

Appendix C: Red Sand Stabilisation

Samples with 14 day curing

Table C-6-9: Preparation of Mixtures

Sample Name	The ratio of Lime: Fly Ash	Total mass (g)	The ratio of RS:FA:LD			Added water (OMC=9.6%)
			RS	FA	LKD	
RSFALKD-1	LD-1:FA-1	2200	70	15	15	211.2
			The weight of each mixture(g)			
			1540	330	330	
RSFALKD-2	LD-1:FA-2	2200	70	20	10	211.2
			The weight of each mixture(g)			
			1540	440	220	
RSFALKD-3	LD-1:FA-3	2200	70	22.5	7.5	211.2
			The weight of each mixture(g)			
			1540	495	165	
RSFALKD-4	LD-1:FA-4	2200	70	24	6	211.2
			The weight of each mixture(g)			
			1540	528	132	
RSFALKD-5	LD-1:FA-5	2200	70	25	5	211.2
			The weight of each mixture(g)			
			1540	550	110	

Table C-6-10: Molding of Specimens

Sample Name	**The ratio of Lime: Fly Ash**	**Wt. Mold**	**Wt. Mold & mixtures**	**Wt. Compacted Mixture**	**Re-weight Sample (g)**
RSFALKD-1	LD-1:FA-1	2018.00	3949.00	1931.00	1923.00
RSFALKD-2	LD-1:FA-2	2018.00	4038.00	2020.00	2012.00
RSFALKD-3	LD-1:FA-3	2018.00	4054.00	2036.00	2027.00
RSFALKD-4	LD-1:FA-4	2018.00	4100.00	2082.00	2073.00
RSFALKD-5	LD-1:FA-5	2018.00	4130.00	2112.00	2105.00

Table C-6-11: Moisture Content

Sample Name	**Wt. Container**	**Wt. Container & wet mixtures**	**Wt. Container & dry mixtures**	**Water Content (%)**
RSFALKD-1	13.34	48.78	45.61	***9.82***
RSFALKD-2	19.23	81.39	75.88	***9.73***
RSFALKD-3	13.11	46.65	43.69	***9.68***
RSFALKD-4	18.35	67.09	62.93	***9.33***
RSFALKD-5	24.01	104.15	97.00	***9.80***

Table C-6-12: UCS Testing

Sample Name	**The ratio of Lime: Fly Ash**	**Age of specimens (Days)**	**Weight before Testing (g)**	**Max. Compressive Loads (kN)**	**UCS strength (kPa)**
RSFALKD-1	LD-1:FA-1	14	1877.00	3.48	***443.31***
RSFALKD-2	LD-1:FA-2	14	1966.00	4.95	***630.57***
RSFALKD-3	LD-1:FA-3	14	1996.00	5.12	***652.23***
RSFALKD-4	LD-1:FA-4	14	2032.00	5.93	***755.41***
RSFALKD-5	LD-1:FA-5	14	2052.00	6.89	***877.71***

Appendix C: Red Sand Stabilisation

Samples with 28 days curing

Table C-6-13: Preparation of Mixtures

Sample Name	The ratio of Lime: Fly Ash	Total mass (g)	The ratio of RS:FA:LD			Added water (OMC=9.6%)
			RS	FA	LKD	
RSFALKD-1	LD-1:FA-1	2200	70	15	15	211.2
			The weight of each mixture(g)			
			1540	330	330	
RSFALKD-2	LD-1:FA-2	2200	70	20	10	211.2
			The weight of each mixture(g)			
			1540	440	220	
RSFALKD-3	LD-1:FA-3	2200	70	22.5	7.5	211.2
			The weight of each mixture(g)			
			1540	495	165	
RSFALKD-4	LD-1:FA-4	2200	70	24	6	211.2
			The weight of each mixture(g)			
			1540	528	132	
RSFALKD-5	LD-1:FA-5	2200	70	25	5	211.2
			The weight of each mixture(g)			
			1540	550	110	

Table C-6-14: Molding of Specimens

Sample Name	The ratio of Lime: Fly Ash	Wt. Mold	Wt. Mold &mixtures	Wt. Compacted Mixture	Re-weight Sample (g)
RSFALKD-1	LD-1:FA-1	2018.00	3968.00	1950.00	1943.00
RSFALKD-2	LD-1:FA-2	2018.00	4029.00	2011.00	2004.00
RSFALKD-3	LD-1:FA-3	2018.00	4090.00	2072.00	2066.00
RSFALKD-4	LD-1:FA-4	2018.00	4117.00	2099.00	2091.00
RSFALKD-5	LD-1:FA-5	2018.00	4146.00	2128.00	2122.00

Table C-6-15: Moisture Content

Sample Name	Wt. Container	Wt. Container & wet mixtures	Wt. Container & dry mixtures	Water Content (%)
RSFALKD-1	23.10	54.64	51.81	***9.86***
RSFALKD-2	22.91	82.04	76.82	***9.68***
RSFALKD-3	22.33	82.17	76.92	***9.62***
RSFALKD-4	23.96	84.92	79.37	***10.02***
RSFALKD-5	23.89	83.11	77.91	***9.63***

Table C-6-16: UCS Testing

Sample Name	The ratio of Lime: Fly Ash	Age of specimens (Days)	Weight before Testing (g)	Max. Compressive Loads (kN)	UCS strength (kPa)
RSFALKD-1	LD-1:FA-1	28	1859.00	3.81	***486.62***
RSFALKD-2	LD-1:FA-2	28	1941.00	5.07	***647.13***
RSFALKD-3	LD-1:FA-3	28	2020.00	5.46	***695.54***
RSFALKD-4	LD-1:FA-4	28	2038.00	6.20	***789.81***
RSFALKD-5	LD-1:FA-5	28	2048.00	8.43	***1073.89***

APPENDIX C-7
RED SAND CALIFORNIA BEARING RATIO

Appendix C: Red Sand Stabilisation

Red Sand Unsoaked CBR

The optimum moisture content for the CBR was selected as the optimum moisture content of the red sand, which was found to be 17%. There were 2 samples taken of the soil prior to testing, to establish the moisture content of the sample. There were 2 samples taken for the moisture content so that the moisture contents of the 2 samples could be averaged to give a more accurate representation of the moisture content of the mixture. It was found that the moisture content was 15%, which is 90% of the optimum moisture content.

Table C-7-1: Moisture Content

		A4	A5
Weight of Wet Soil + Container	g	62.4	63.85
Weight of Dry Soil + Container	g	56.22	58.11
Weight of Water	g	6.18	5.74
Weight of Container	g	18.31	19.2
Weight of Dry Soil	g	38.91	39.91
Water Content	%	15.88	14.38
Average Water Content	%	**15.13**	

The maximum dry density for the red sand was found to be 1.82 g/cm^3 in the modified compaction test. The dry density of the sample was calculated as 1.67 g/cm^3 which is 92% of the MDD.

Table C-7-2: Molding of Specimens

Weight of Wet Soil + Mould + Base Plate	g	11278
Weight of Mould + Base Plate	g	7194
Weight of Wet Soil	g	4084
Wet Density,	g/cm^3	1.92
Dry Soil Density	g/cm^3	**1.67**

The results of the penetration test are shown in the table below:

Table C-7-3: Load Penetration Test Data

PENETRATION (mm)	Force Gauge Reading (kN)
0.000	0.00
0.500	0.55
1.000	1.12
1.500	1.80
2.000	2.53
2.500	**3.25**
3.000	3.95
4.000	5.30
5.000	**6.48**
7.500	8.93
10.000	10.78
12.500	11.55

The load penetration curve is shown in the figure below:

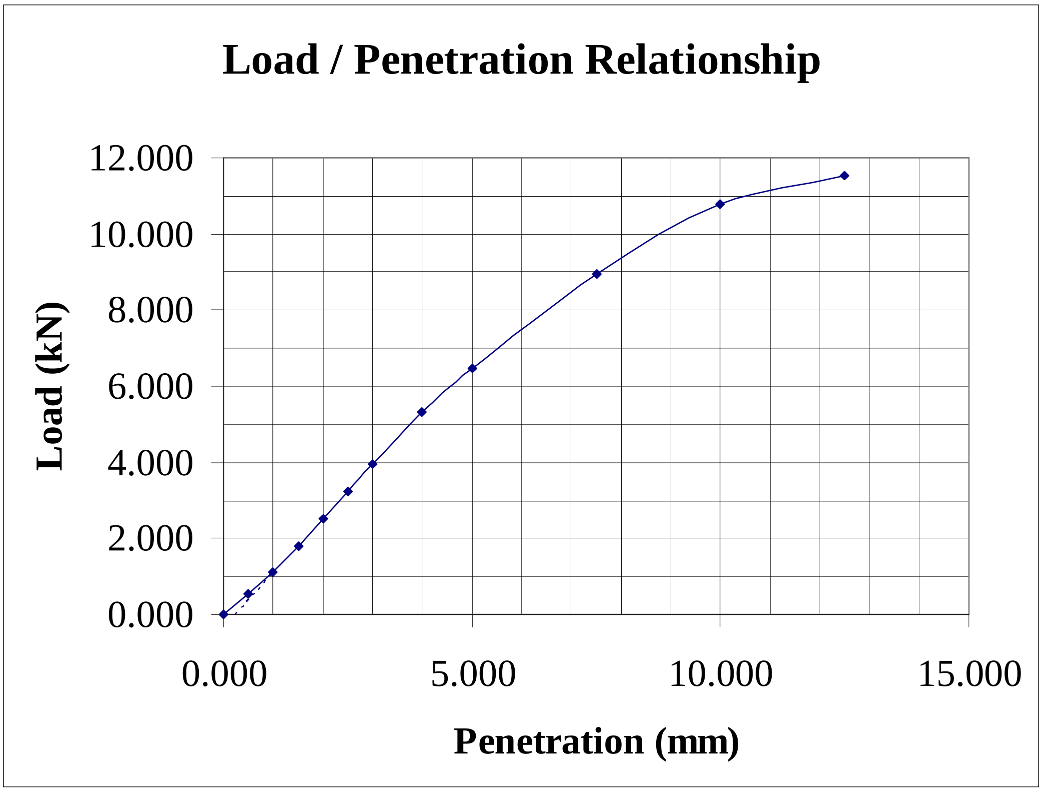


Figure C-7-1: Load Penetration Curve

As can be seen the curve is concave upward initially, due to surface irregularities of the specimen, meaning that there needs to be a correction made to the graph, which is shown in the figure above, as the dotted line. The new values for the loads are read, with this point now as the zero datum.

CBR calculations

CBR = (force @ 2.5mm / 13.2) * 100 &
CBR = (force @ 5mm / 19.8) * 100

Force @ 2.5mm = 3.3 kN
CBR = 25 %

Force @ 5mm = 6.55 kN
CBR = 33.1 %
CBR = 33%

APPENDIX C-8

CRUSHED ROCK CALIFORNIA BEARING RATIO

Appendix C: Red Sand Stabilisation

Crushed Rock Unsoaked CBR

Mass of mould & wet soil = 12058g

Mass of mould = 7069g

Mass of wet soil = 4989g

Volume of CBR mould = л r^2 h = л $(7.6)^2$ (11.7) = 2123 cm^3

$\gamma_{wet} = \frac{wet \quad mass}{volume}$ = 4989 / 2123 = 2.35g/cm^3

$\gamma_{dry} = \frac{wet\ density}{1+w}$

Moisture Content

Container = A3

Mass of container = 23.2g

Mass of container & wet soil = 158.4g

Mass of container & dry soil = 151.1g

Mass of water = 7.4g

Mass of wet soil = 135.2g

Moisture content = 5.5%

OMC = 5.7%

Thus moisture content is 97% of OMC

$\gamma_{dry} = \frac{2.35}{1+0.054}$ = 2.23g/cm^3 = 2.23tonnes/m^3

Max γ_{dry} = 2.29 tonnes/m^3

Thus dry density is 97% of the max γ_{dry}

<u>Appendix C: Red Sand Stabilisation</u>

The results of the penetration test are shown in the table below:

Table C-8-1: Load Penetration Test Data

Penetration (mm)	**Force (kN)**
0	0.03
0.5	0.65
1	2.05
1.5	4.55
2	7.88
2.5	11.1
3	14.8
4	22.5
5	30
7.5	47
10	
12.5	

The load penetration curve is shown in the figure below:

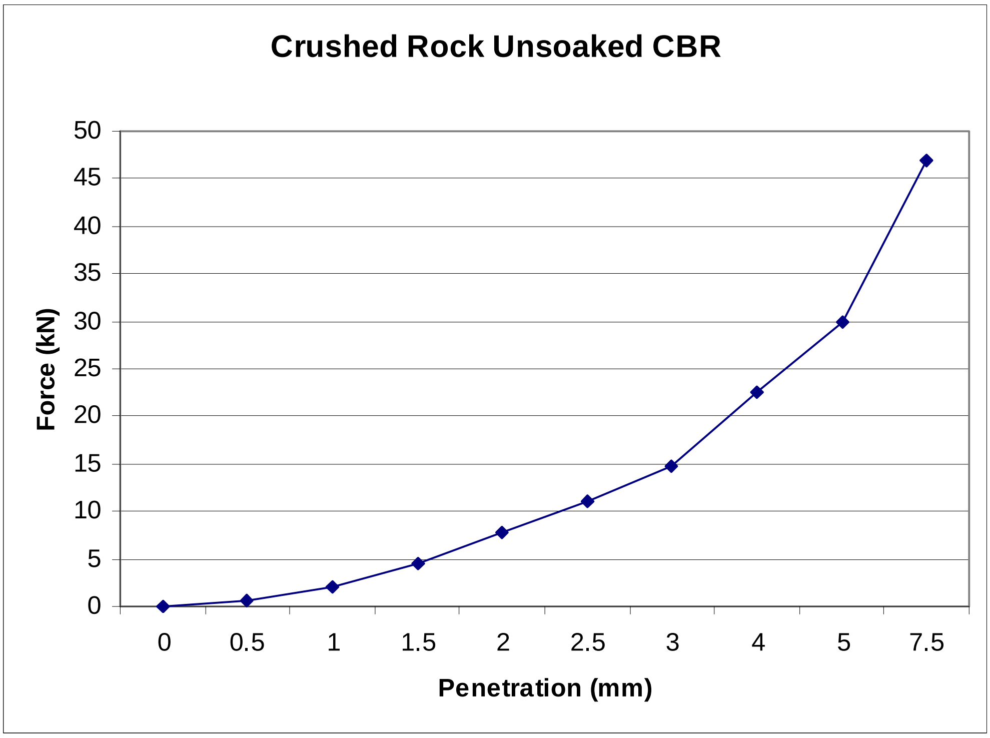


Figure C-8-1: Load Penetration Curve

It can be seen from the graph that the curve is concave up for the entirety of the graph, meaning that there is no correction required.

CBR calculations

CBR = (force @ 2.5mm / 13.2) * 100 &
CBR = (force @ 5mm / 19.8) * 100

Force @ 2.5mm = 11.1 kN
CBR = 84.1 %

Force @ 5mm = 30 kN
CBR = 151.5 %

CBR = 152 %

Appendix C: Red Sand Stabilisation

Crushed Rock Soaked CBR

Main Roads requires that, for the CBR tests on the crushed rock, the moisture content of the sample must at be at 98% of MDD and 100% of OMC.

Mass of mould & wet soil = 12605g

Mass of mould = 7531g

Mass of wet soil = 5074g

Volume of CBR mould = л r^2 h = л $(7.6)^2$ (11.7) = 2123 cm^3

$$\gamma_{wet} = \frac{wet \quad mass}{volume} = 5074 / 2123 = 2.39 g/cm^3$$

$$\gamma_{dry} = \frac{wet\ density}{1+w}$$

Moisture Content

Container = A3

Mass of container = 23.2g

Mass of container & wet soil = 163.5g

Mass of container & dry soil = 155.7g

Mass of water = 7.8g

Mass of wet soil = 140.3g

Moisture content = 5.56%

OMC = 5.7%

Thus moisture content is 98% of OMC

$$\gamma_{dry} = \frac{2.39}{1+0.053} = 2.27\text{g/cm}^3 = 2.27\text{tonnes/m}^3$$

Max γ_{dry} = 2.29 tonnes/m^3

Thus dry density is 99% of the max γ_{dry}

The results for the penetration test are shown in the table below:

Table C-8-2: Load Penetration Test Data

Penetration (mm)	Force (kN)
0	0.09
0.5	1.36
1	3.3
1.5	5.56
2	8.08
2.5	10.76
3	13.49
4	18.78
5	23.9
7.5	31.25
10	
12.5	

The load penetration curve for the soaked CBR test is shown below:

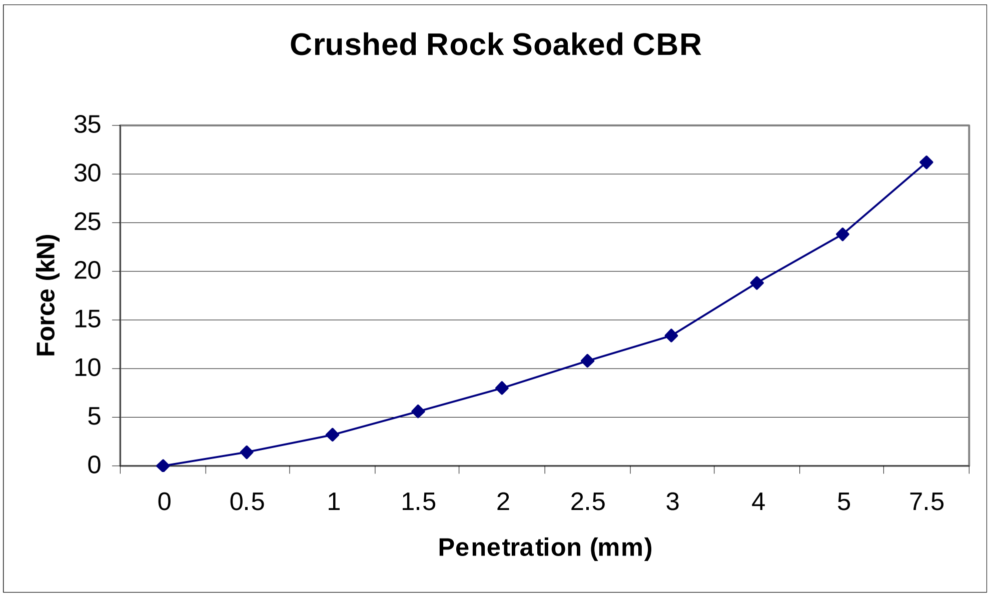


Figure C-8-2: Load Penetration Curve

It can be seen from the graph that the curve is concave up for the entirety of the graph, meaning that there is no correction required.

CBR Calculations

CBR = (force @ 2.5mm / 13.2) * 100 &
CBR = (force @ 5mm / 19.8) * 100

Force @ 2.5mm = 10.76 kN
CBR = 81.5 %

Force @ 5mm = 23.9 kN
CBR = 120.7 %

CBR = 121 %

APPENDIX C-9

CRUSHED ROCK MAXIMUM DRY COMPRESSIVE STRENGTH

Appendix C: Red Sand Stabilisation

$$\sigma = \frac{P}{A}$$

Mould is square in plan with sides of length = 5.478 cm

A = 5.478^2

A = 30.01 cm^2 = 0.003 m^2

Table C-9-1: Maximum Dry Compressive Strength for Crushed Rock

Sample No.	**P (kN)**	**A (m^3)**	**σ (kPa)**
Sample 1	11.89	0.003	**3960**
Sample 2	11.10	0.003	**3700**
Sample 3	11.71	0.003	**3900**

Table C-9-2: Moisture Contents

		Sample #		
		1	2	3
Assumed Water Content	%	5.7	5.5	5.9
Container	#	A1	A2	A3
Weight of Wet Soil + Container	g	68.43	72.56	69.90
Weight of Dry Soil + Container	g	66.05	69.89	67.09
Weight of Water	g	2.38	2.67	2.81
Weight of Container	g	23.26	19.26	19.03
Weight of Dry Soil	g	42.79	50.63	48.06
Actual Water Content	%	**5.58**	**5.27**	**5.85**

APPENDIX C-10

RESILIENT MODULUS TEST

Appendix C: Red Sand Stabilisation

Stabilised red sand

IPC Global Universal Testing Machine
UTM_41 V2.03b Resilient Modulus Test

Filename		D:\my research\Lab test Data\Resilient Modulus\Resilient modulus\					
Operator		Peerapong Jitsangiam					
Test method		Non Standard Testing					
Notes/Comments		ths test follows the standard of Ausroads (APRG 00/33(MA))					
Specimen Information							
********************							
Identification	RSFALKD						
Core/Sample Number	1						
Dimensions	Point 1	Point 2	Point 3	Point 4	Point 5	Average	Std Dev.
Diameter (mm)	100					100	
Height (mm)	200					200	
Cross-Sectional area	7853.982						
Volume	1570796						
Comments/Properties							
Setup Parameters							
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Dynamic loading options							
Wave shape	Square pulse						
Load duration (msec)	1000						
Cycle duration (msec)	3000						
Contact stress [% of max. stress]	1						
Conditioning Cycles	1000						
Cycles per test sequence	200						
Shear test options							
Confining pressure (kPa)	34.5						
Strain rate (%/min)	1						
Gauge length (mm)	200						
Test termination strain (%)							

Sequence #	Confining Pressure (kPa)	Maximum Stress (kPa)
0	50	100
1	75	150
2	100	200
3	125	250
4	150	300
5	100	200
6	50	150
7	75	225
8	100	300
9	125	375
10	150	450
11	75	225
12	40	125
13	30	100
14	40	150
15	50	200
16	75	300
17	100	400
18	125	500
19	75	300
20	30	125
21	20	100
22	30	150
23	40	200
24	50	250
25	75	375
26	100	500
27	50	250
28	30	180
29	50	300
30	75	450
31	50	300
32	30	180
33	40	250
34	30	210
35	40	280
36	50	350
37	75	525
38	40	280
39	20	150

40	30	245					
41	40	325					
42	50	400					
43	30	245					
44	20	185					
45	30	275					
46	40	370					
47	50	450					
48	30	275					
49	20	225					
50	30	335					
51	40	450					
52	50	550					
53	20	250					
54	30	375					
55	40	500					
56	20	300					
57	30	450					
58	40	600					
59	30	500					
60	20	350					
61	30	550					
62	20	375					
63	30	575					
64	20	400					
65	20	500					
Calibration Information							
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Channel description	Filename	Transducer description	Span	Units	Date	Linearised	
A: Axial Force	Y12346.CAR	STC5000 S/N: Y12346 +/-20kN	40	kN	7/12/2005	No	
B: Actuator LVDT	941C-340.CAR	AC-15 S/N: M992941C-340 +/-15mm	30	mm	7/12/2005	No	
C: Axial LVDT #1	83047.car	D6-05000A S/N: 83047 +/-5mm	10	mm	20/12/2005	Yes	
D: Axial LVDT #2	83048.car	D6-05000A S/N: 83048 +/-5mm	10	mm	20/12/2005	Yes	
E: Confining Pressure	S054042.CAR	Pressure S/N: S054042 +/-600kPa	1200	kPa	22/02/2006	No	
Test Results							
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Start date and time	Tuesday	October 17	2006	at 4:27 PM			
Sequence Number	0						
Cycle Number	996	997	998	999	1000	Average	Std Dev.
Resilient Modulus (MPa)	277.669908	263.542467	272.914157	273.284901	260.248186	269.531924	7.311164
Resilient micro-strain	353.846154	377.533578	360.01221	359.52381	377.533578	365.689866	11.080124
Confining pressure (kPa)	50.40293	50.40293	50.40293	50.40293	50.40293	50.40293	0
Maximum axial stress (kPa)	100.739832	101.983534	100.739832	100.739832	101.983534	101.237313	0.681203
Cyclic stress (kPa)	98.252429	99.49613	98.252429	98.252429	98.252429	98.501169	0.5562
Contact stress (kPa)	2.487403	2.487403	2.487403	2.487403	3.731105	2.736144	0.5562
Permanent strain (%)	0.036667	0.036099	0.036667	0.037283	0.036099	0.036563	0.000493
Maximum load (kN)	0.791209	0.800977	0.791209	0.791209	0.800977	0.795116	0.00535
Cyclic load (kN)	0.771673	0.781441	0.771673	0.771673	0.771673	0.773626	0.004368
Contact load (kN)	0.019536	0.019536	0.019536	0.019536	0.029304	0.02149	0.004368
Average resilient def. (mm)	0.070769	0.075507	0.072002	0.071905	0.075507	0.073138	0.002216
Axial 1 resilient def. (mm)	0.066593	0.071526	0.06906	0.066593	0.071526	0.06906	0.002466
Axial 2 resilient def. (mm)	0.074945	0.079487	0.074945	0.077216	0.079487	0.077216	0.002271
Actuator resilient def. (mm)	0.117216	0.131868	0.124542	0.117216	0.131868	0.124542	0.007326
Average permanent def. (mm)	0.073333	0.072198	0.073333	0.074567	0.072198	0.073126	0.000985
Axial 1 permanent def. (mm)	0.073993	0.073993	0.073993	0.076459	0.073993	0.074486	0.001103
Axial 2 permanent def. (mm)	0.072674	0.070403	0.072674	0.072674	0.070403	0.071766	0.001244
Actuator permanent def. (mm)	0.080586	0.080586	0.080586	0.087912	0.07326	0.080586	0.00518
Sequence Number	1						
Cycle Number	196	197	198	199	200	Average	Std Dev.
Resilient Modulus (MPa)	290.677229	285.200944	297.892368	295.389071	291.767965	292.185515	4.849342
Resilient micro-strain	509.157509	527.655678	496.825397	496.825397	502.991453	506.691087	12.786206
Confining pressure (kPa)	75.311355	75.311355	74.725275	75.604396	75.604396	75.311355	0.3589
Maximum axial stress (kPa)	151.731599	152.975301	150.487897	150.487897	150.487897	151.234118	1.112401
Cyclic stress (kPa)	148.000494	150.487897	148.000494	146.756792	146.756792	148.000494	1.523217
Contact stress (kPa)	3.731105	2.487403	2.487403	3.731105	3.731105	3.233624	0.681203
Permanent strain (%)	0.059737	0.060354	0.060354	0.060354	0.060354	0.060231	0.000276
Maximum load (kN)	1.191697	1.201465	1.181929	1.181929	1.181929	1.18779	0.008737
Cyclic load (kN)	1.162393	1.181929	1.162393	1.152625	1.152625	1.162393	0.011963
Contact load (kN)	0.029304	0.019536	0.019536	0.029304	0.029304	0.025397	0.00535
Average resilient def. (mm)	0.101832	0.105531	0.099365	0.099365	0.100598	0.101338	0.002557
Axial 1 resilient def. (mm)	0.098657	0.101123	0.09619	0.09619	0.098657	0.098164	0.002064
Axial 2 resilient def. (mm)	0.105006	0.109939	0.10254	0.10254	0.10254	0.104513	0.003216
Actuator resilient def. (mm)	0.175824	0.18315	0.168498	0.161172	0.168498	0.171429	0.008353
Average permanent def. (mm)	0.119475	0.120708	0.120708	0.120708	0.120708	0.120462	0.000552
Axial 1 permanent def. (mm)	0.120855	0.123321	0.123321	0.123321	0.123321	0.122828	0.001103
Axial 2 permanent def. (mm)	0.118095	0.118095	0.118095	0.118095	0.118095	0.118095	0
Actuator permanent def. (mm)	0.117216	0.117216	0.117216	0.117216	0.117216	0.117216	0

Appendix C: Red Sand Stabilisation

Sequence Number	2						
Cycle Number	196	197	198	199	200	Average	Std Dev.
Resilient Modulus (MPa)	327.250091	317.529791	327.250091	328.544408	325.191914	325.153259	4.427529
Resilient micro-strain	604.273504	622.771673	604.273504	598.107448	604.273504	606.739927	9.351287
Confining pressure (kPa)	100.512821	100.512821	100.21978	100.512821	100.512821	100.454212	0.131052
Maximum axial stress (kPa)	201.479664	201.479664	201.479664	200.235963	200.235963	200.982184	0.681203
Cyclic stress (kPa)	197.748559	197.748559	197.748559	196.504858	196.504858	197.251079	0.681203
Contact stress (kPa)	3.731105	3.731105	3.731105	3.731105	3.731105	3.731105	0
Permanent strain (%)	0.099554	0.099554	0.099554	0.100171	0.099554	0.099678	0.000276
Maximum load (kN)	1.582418	1.582418	1.582418	1.57265	1.57265	1.57851	0.00535
Cyclic load (kN)	1.553114	1.553114	1.553114	1.543346	1.543346	1.549206	0.00535
Contact load (kN)	0.029304	0.029304	0.029304	0.029304	0.029304	0.029304	0
Average resilient def. (mm)	0.120855	0.124554	0.120855	0.119621	0.120855	0.121348	0.00187
Axial 1 resilient def. (mm)	0.115922	0.120855	0.115922	0.115922	0.115922	0.116908	0.002206
Axial 2 resilient def. (mm)	0.125788	0.128254	0.125788	0.123321	0.125788	0.125788	0.001744
Actuator resilient def. (mm)	0.197802	0.205128	0.197802	0.197802	0.197802	0.199267	0.003276
Average permanent def. (mm)	0.199109	0.199109	0.199109	0.200342	0.199109	0.199355	0.000552
Axial 1 permanent def. (mm)	0.202247	0.202247	0.202247	0.202247	0.202247	0.202247	0
Axial 2 permanent def. (mm)	0.195971	0.195971	0.195971	0.198437	0.195971	0.196464	0.001103
Actuator permanent def. (mm)	0.190476	0.190476	0.190476	0.190476	0.190476	0.190476	0
Sequence Number	3						
Cycle Number	196	197	198	199	200	Average	Std Dev.
Resilient Modulus (MPa)	362.174086	355.721596	354.386125	358.966999	350.025446	356.25485	4.609096
Resilient micro-strain	676.495726	688.766789	694.871795	682.539683	707.081807	689.95116	11.779783
Confining pressure (kPa)	125.714286	125.714286	125.421245	125.421245	125.421245	125.538462	0.160505
Maximum axial stress (kPa)	249.984028	249.984028	251.227729	249.984028	252.471431	250.730249	1.112401
Cyclic stress (kPa)	245.009221	245.009221	246.252923	245.009221	247.496625	245.755442	1.112401
Contact stress (kPa)	4.974807	4.974807	4.974807	4.974807	4.974807	4.974807	0
Permanent strain (%)	0.150116	0.149499	0.149499	0.150733	0.149499	0.149869	0.000552
Maximum load (kN)	1.96337	1.96337	1.973138	1.96337	1.982906	1.969231	0.008737
Cyclic load (kN)	1.924298	1.924298	1.934066	1.924298	1.943834	1.930159	0.008737
Contact load (kN)	0.039072	0.039072	0.039072	0.039072	0.039072	0.039072	0
Average resilient def. (mm)	0.135299	0.137753	0.138974	0.136508	0.141416	0.13799	0.002356
Axial 1 resilient def. (mm)	0.12044	0.125348	0.125348	0.122882	0.12779	0.124361	0.002796
Axial 2 resilient def. (mm)	0.150159	0.150159	0.152601	0.150134	0.155043	0.151619	0.002188
Actuator resilient def. (mm)	0.227106	0.227106	0.234432	0.227106	0.241758	0.231502	0.006553
Average permanent def. (mm)	0.300232	0.298999	0.298999	0.301465	0.298999	0.299739	0.001103
Axial 1 permanent def. (mm)	0.315702	0.313236	0.313236	0.315702	0.313236	0.314222	0.001351
Axial 2 permanent def. (mm)	0.284762	0.284762	0.284762	0.287228	0.284762	0.285255	0.001103
Actuator permanent def. (mm)	0.29304	0.285714	0.285714	0.29304	0.285714	0.288645	0.004013
Sequence Number	4						
Cycle Number	196	197	198	199	200	Average	Std Dev.
Resilient Modulus (MPa)	378.31587	375.35776	370.880654	366.810122	345.629896	367.39886	12.931381
Resilient micro-strain	782.417582	788.583639	794.749695	806.959707	856.410256	805.824176	29.698442
Confining pressure (kPa)	150.32967	150.32967	150.915751	150.622711	150.32967	150.505495	0.262103
Maximum axial stress (kPa)	300.975795	300.975795	299.732093	300.975795	300.975795	300.727054	0.5562
Cyclic stress (kPa)	296.000988	296.000988	294.757287	296.000988	296.000988	295.752248	0.5562
Contact stress (kPa)	4.974807	4.974807	4.974807	4.974807	4.974807	4.974807	0
Permanent strain (%)	0.190195	0.189579	0.188962	0.188962	0.182796	0.188099	0.003008
Maximum load (kN)	2.363858	2.363858	2.35409	2.363858	2.363858	2.361905	0.004368
Cyclic load (kN)	2.324786	2.324786	2.315018	2.324786	2.324786	2.322833	0.004368
Contact load (kN)	0.039072	0.039072	0.039072	0.039072	0.039072	0.039072	0
Average resilient def. (mm)	0.156484	0.157717	0.15895	0.161392	0.171282	0.161165	0.00594
Axial 1 resilient def. (mm)	0.144078	0.146545	0.146545	0.148987	0.158877	0.149006	0.005784
Axial 2 resilient def. (mm)	0.168889	0.168889	0.171355	0.173797	0.183687	0.173324	0.006141
Actuator resilient def. (mm)	0.271062	0.271062	0.271062	0.278388	0.278388	0.273993	0.004013
Average permanent def. (mm)	0.380391	0.379158	0.377924	0.377924	0.365592	0.376198	0.006016
Axial 1 permanent def. (mm)	0.394628	0.392161	0.392161	0.392161	0.379829	0.390188	0.005889
Axial 2 permanent def. (mm)	0.366154	0.366154	0.363687	0.363687	0.351355	0.362208	0.006191
Actuator permanent def. (mm)	0.351648	0.351648	0.351648	0.351648	0.344322	0.350183	0.003276
Sequence Number	5						
Cycle Number	196	197	198	199	200	Average	Std Dev.
Resilient Modulus (MPa)	326.228362	322.12486	329.547401	322.12486	317.712918	323.54768	4.50766
Resilient micro-strain	606.166056	606.166056	600.06105	606.166056	618.498168	607.411477	6.737891
Confining pressure (kPa)	100.21978	100.512821	100.21978	100.21978	100.805861	100.395604	0.262103
Maximum axial stress (kPa)	202.723366	200.235963	201.479664	200.235963	201.479664	201.230924	1.040555
Cyclic stress (kPa)	197.748559	195.261156	197.748559	195.261156	196.504858	196.504858	1.243702
Contact stress (kPa)	4.974807	4.974807	3.731105	4.974807	4.974807	4.726066	0.5562
Permanent strain (%)	0.182179	0.182179	0.182179	0.182179	0.180946	0.181933	0.000552
Maximum load (kN)	1.592186	1.57265	1.582418	1.57265	1.582418	1.580464	0.008173
Cyclic load (kN)	1.553114	1.533578	1.553114	1.533578	1.543346	1.543346	0.009768
Contact load (kN)	0.039072	0.039072	0.029304	0.039072	0.039072	0.037118	0.004368
Average resilient def. (mm)	0.121233	0.121233	0.120012	0.121233	0.1237	0.121482	0.001348
Axial 1 resilient def. (mm)	0.112503	0.112503	0.112503	0.112503	0.114969	0.112996	0.001103
Axial 2 resilient def. (mm)	0.129963	0.129963	0.127521	0.129963	0.13243	0.129968	0.001735
Actuator resilient def. (mm)	0.197802	0.197802	0.205128	0.197802	0.205128	0.200733	0.004013
Average permanent def. (mm)	0.364359	0.364359	0.364359	0.364359	0.361893	0.363866	0.001103
Axial 1 permanent def. (mm)	0.377363	0.377363	0.377363	0.377363	0.374896	0.376869	0.001103

Axial 2 permanent def. (mm)	0.351355	0.351355	0.351355	0.351355	0.348889	0.350862	0.001103
Actuator permanent def. (mm)	0.358974	0.351648	0.351648	0.358974	0.351648	0.354579	0.004013
Sequence Number	6						
Cycle Number	196	197	198	199	200	Average	Std Dev.
Resilient Modulus (MPa)	288.979683	290.39867	290.39867	287.958345	287.958345	289.138742	1.223398
Resilient micro-strain	503.540904	509.64591	509.64591	509.64591	509.64591	508.424908	2.730242
Confining pressure (kPa)	50.40293	50.40293	50.10989	50.695971	50.40293	50.40293	0.207211
Maximum axial stress (kPa)	149.244196	150.487897	150.487897	150.487897	150.487897	150.239157	0.5562
Cyclic stress (kPa)	145.513091	148.000494	148.000494	146.756792	146.756792	147.005533	1.040555
Contact stress (kPa)	3.731105	2.487403	2.487403	3.731105	3.731105	3.233624	0.681203
Permanent strain (%)	0.170464	0.170464	0.170464	0.170464	0.170464	0.170464	0
Maximum load (kN)	1.172161	1.181929	1.181929	1.181929	1.181929	1.179976	0.004368
Cyclic load (kN)	1.142857	1.162393	1.162393	1.152625	1.152625	1.154579	0.008173
Contact load (kN)	0.029304	0.019536	0.019536	0.029304	0.029304	0.025397	0.00535
Average resilient def. (mm)	0.100708	0.101929	0.101929	0.101929	0.101929	0.101685	0.000546
Axial 1 resilient def. (mm)	0.095653	0.095653	0.095653	0.095653	0.095653	0.095653	0
Axial 2 resilient def. (mm)	0.105763	0.108205	0.108205	0.108205	0.108205	0.107717	0.001092
Actuator resilient def. (mm)	0.168498	0.168498	0.153846	0.168498	0.168498	0.165568	0.006553
Average permanent def. (mm)	0.340928	0.340928	0.340928	0.340928	0.340928	0.340928	0
Axial 1 permanent def. (mm)	0.352698	0.352698	0.352698	0.352698	0.352698	0.352698	0
Axial 2 permanent def. (mm)	0.329158	0.329158	0.329158	0.329158	0.329158	0.329158	0
Actuator permanent def. (mm)	0.351648	0.351648	0.358974	0.351648	0.351648	0.353114	0.003276
Sequence Number	7						
Cycle Number	196	197	198	199	200	Average	Std Dev.
Resilient Modulus (MPa)	344.203723	340.935147	340.935147	342.269994	340.935147	341.855832	1.434147
Resilient micro-strain	643.162393	649.328449	649.328449	643.162393	649.328449	646.862027	3.377288
Confining pressure (kPa)	75.604396	75.897436	75.311355	75.311355	75.604396	75.545788	0.245175
Maximum axial stress (kPa)	225.109995	225.109995	225.109995	223.866294	225.109995	224.861255	0.5562
Cyclic stress (kPa)	221.37889	221.37889	221.37889	220.135189	221.37889	221.13015	0.5562
Contact stress (kPa)	3.731105	3.731105	3.731105	3.731105	3.731105	3.731105	0
Permanent strain (%)	0.17848	0.177863	0.177863	0.17848	0.177863	0.17811	0.000338
Maximum load (kN)	1.76801	1.76801	1.76801	1.758242	1.76801	1.766056	0.004368
Cyclic load (kN)	1.738706	1.738706	1.738706	1.728938	1.738706	1.736752	0.004368
Contact load (kN)	0.029304	0.029304	0.029304	0.029304	0.029304	0.029304	0
Average resilient def. (mm)	0.128632	0.129866	0.129866	0.128632	0.129866	0.129372	0.000675
Axial 1 resilient def. (mm)	0.119902	0.122369	0.122369	0.119902	0.122369	0.121382	0.001351
Axial 2 resilient def. (mm)	0.137363	0.137363	0.137363	0.137363	0.137363	0.137363	0
Actuator resilient def. (mm)	0.21978	0.21978	0.212454	0.212454	0.212454	0.215385	0.004013
Average permanent def. (mm)	0.35696	0.355726	0.355726	0.35696	0.355726	0.35622	0.000675
Axial 1 permanent def. (mm)	0.369963	0.367497	0.367497	0.369963	0.367497	0.368484	0.001351
Axial 2 permanent def. (mm)	0.343956	0.343956	0.343956	0.343956	0.343956	0.343956	0
Actuator permanent def. (mm)	0.358974	0.358974	0.358974	0.358974	0.358974	0.358974	0
Sequence Number	8						
Cycle Number	196	197	198	199	200	Average	Std Dev.
Resilient Modulus (MPa)	384.496129	378.493067	381.265069	381.265069	376.87334	380.478535	2.929072
Resilient micro-strain	769.84127	782.051282	769.84127	769.84127	782.112332	774.737485	6.704453
Confining pressure (kPa)	100.512821	100.805861	100.512821	100.512821	100.805861	100.630037	0.160505
Maximum axial stress (kPa)	300.975795	300.975795	299.732093	299.732093	299.732093	300.229574	0.681203
Cyclic stress (kPa)	296.000988	296.000988	293.513585	293.513585	294.757287	294.757287	1.243702
Contact stress (kPa)	4.974807	4.974807	6.218508	6.218508	4.974807	5.472287	0.681203
Permanent strain (%)	0.196947	0.196947	0.196947	0.196947	0.19572	0.196702	0.000549
Maximum load (kN)	2.363858	2.363858	2.35409	2.35409	2.35409	2.357998	0.00535
Cyclic load (kN)	2.324786	2.324786	2.30525	2.30525	2.315018	2.315018	0.009768
Contact load (kN)	0.039072	0.039072	0.04884	0.04884	0.039072	0.042979	0.00535
Average resilient def. (mm)	0.153968	0.15641	0.153968	0.153968	0.156422	0.154947	0.001341
Axial 1 resilient def. (mm)	0.144078	0.14652	0.144078	0.144078	0.14652	0.145055	0.001338
Axial 2 resilient def. (mm)	0.163858	0.1663	0.163858	0.163858	0.166325	0.16484	0.001344
Actuator resilient def. (mm)	0.263736	0.263736	0.263736	0.263736	0.263736	0.263736	0
Average permanent def. (mm)	0.393895	0.393895	0.393895	0.393895	0.391441	0.393404	0.001098
Axial 1 permanent def. (mm)	0.406838	0.406838	0.406838	0.406838	0.404396	0.406349	0.001092
Axial 2 permanent def. (mm)	0.380952	0.380952	0.380952	0.380952	0.378486	0.380459	0.001103
Actuator permanent def. (mm)	0.388278	0.388278	0.388278	0.388278	0.380952	0.386813	0.003276
Sequence Number	9						
Cycle Number	196	197	198	199	200	Average	Std Dev.
Resilient Modulus (MPa)	404.70218	407.436654	406.069417	403.38927	402.040142	404.727533	2.130355
Resilient micro-strain	909.64591	903.540904	909.64591	921.855922	921.855922	913.308913	8.190725
Confining pressure (kPa)	125.714286	125.421245	125.421245	125.421245	125.128205	125.421245	0.207211
Maximum axial stress (kPa)	374.354191	374.354191	375.597893	376.841594	376.841594	375.597893	1.243702
Cyclic stress (kPa)	368.135683	368.135683	369.379384	371.866788	370.623086	369.628125	1.621589
Contact stress (kPa)	6.218508	6.218508	6.218508	4.974807	6.218508	5.969768	0.5562
Permanent strain (%)	0.242796	0.242796	0.242796	0.242796	0.242796	0.242796	0
Maximum load (kN)	2.940171	2.940171	2.949939	2.959707	2.959707	2.949939	0.009768
Cyclic load (kN)	2.891331	2.891331	2.901099	2.920635	2.910867	2.903053	0.012736
Contact load (kN)	0.04884	0.04884	0.04884	0.039072	0.04884	0.046886	0.004368
Average resilient def. (mm)	0.181929	0.180708	0.181929	0.184371	0.184371	0.182662	0.001638
Axial 1 resilient def. (mm)	0.17094	0.17094	0.17094	0.173382	0.173382	0.171917	0.001338
Axial 2 resilient def. (mm)	0.192918	0.190476	0.192918	0.19536	0.19536	0.193407	0.002043

Appendix C: Red Sand Stabilisation

Actuator resilient def. (mm)	0.315018	0.315018	0.315018	0.322344	0.322344	0.317949	0.004013
Average permanent def. (mm)	0.485592	0.485592	0.485592	0.485592	0.485592	0.485592	0
Axial 1 permanent def. (mm)	0.497192	0.497192	0.497192	0.497192	0.497192	0.497192	0
Axial 2 permanent def. (mm)	0.473993	0.473993	0.473993	0.473993	0.473993	0.473993	0
Actuator permanent def. (mm)	0.468864	0.468864	0.468864	0.468864	0.468864	0.468864	0
Sequence Number	10						
Cycle Number	196	197	198	199	200	Average	Std Dev.
Resilient Modulus (MPa)	417.973809	413.257178	415.585387	413.257178	413.224107	414.659532	2.111592
Resilient micro-strain	1062.271062	1068.376068	1068.376068	1068.376068	1074.481074	1068.376068	4.316891
Confining pressure (kPa)	150.32967	150.32967	150.32967	150.32967	150.32967	150.32967	0
Maximum axial stress (kPa)	450.21999	448.976289	450.21999	448.976289	450.21999	449.72251	0.681203
Cyclic stress (kPa)	444.001482	441.514079	444.001482	441.514079	444.001482	443.006521	1.362407
Contact stress (kPa)	6.218508	7.46221	6.218508	7.46221	6.218508	6.715989	0.681203
Permanent strain (%)	0.311172	0.311172	0.311783	0.311172	0.311172	0.311294	0.000273
Maximum load (kN)	3.53602	3.526252	3.53602	3.526252	3.53602	3.532112	0.00535
Cyclic load (kN)	3.487179	3.467643	3.487179	3.467643	3.487179	3.479365	0.0107
Contact load (kN)	0.04884	0.058608	0.04884	0.058608	0.04884	0.052747	0.00535
Average resilient def. (mm)	0.212454	0.213675	0.213675	0.213675	0.214896	0.213675	0.000863
Axial 1 resilient def. (mm)	0.202686	0.205128	0.205128	0.205128	0.205128	0.20464	0.001092
Axial 2 resilient def. (mm)	0.222222	0.222222	0.222222	0.222222	0.224664	0.222711	0.001092
Actuator resilient def. (mm)	0.3663	0.3663	0.3663	0.3663	0.3663	0.3663	0
Average permanent def. (mm)	0.622344	0.622344	0.623565	0.622344	0.622344	0.622589	0.000546
Axial 1 permanent def. (mm)	0.631502	0.631502	0.631502	0.631502	0.631502	0.631502	0
Axial 2 permanent def. (mm)	0.613187	0.613187	0.615629	0.613187	0.613187	0.613675	0.001092
Actuator permanent def. (mm)	0.608059	0.608059	0.615385	0.608059	0.608059	0.609524	0.003276
Sequence Number	11						
Cycle Number	196	197	198	199	200	Average	Std Dev.
Resilient Modulus (MPa)	316.114646	317.870838	316.114646	321.660517	317.870838	317.926297	2.264658
Resilient micro-strain	708.180708	708.180708	708.180708	695.970696	708.180708	705.738706	5.460483
Confining pressure (kPa)	75.604396	75.311355	75.604396	75.311355	75.018315	75.369963	0.245175
Maximum axial stress (kPa)	227.597398	228.8411	227.597398	227.597398	228.8411	228.094879	0.681203
Cyclic stress (kPa)	223.866294	225.109995	223.866294	223.866294	225.109995	224.363774	0.681203
Contact stress (kPa)	3.731105	3.731105	3.731105	3.731105	3.731105	3.731105	0
Permanent strain (%)	0.29652	0.29652	0.29652	0.29652	0.29652	0.29652	0
Maximum load (kN)	1.787546	1.797314	1.787546	1.787546	1.797314	1.791453	0.00535
Cyclic load (kN)	1.758242	1.76801	1.758242	1.758242	1.76801	1.762149	0.00535
Contact load (kN)	0.029304	0.029304	0.029304	0.029304	0.029304	0.029304	0
Average resilient def. (mm)	0.141636	0.141636	0.141636	0.139194	0.141636	0.141148	0.001092
Axial 1 resilient def. (mm)	0.136752	0.136752	0.136752	0.13431	0.136752	0.136264	0.001092
Axial 2 resilient def. (mm)	0.14652	0.14652	0.14652	0.144078	0.14652	0.146032	0.001092
Actuator resilient def. (mm)	0.234432	0.234432	0.234432	0.227106	0.241758	0.234432	0.00518
Average permanent def. (mm)	0.59304	0.59304	0.59304	0.59304	0.59304	0.59304	0
Axial 1 permanent def. (mm)	0.599756	0.599756	0.599756	0.599756	0.599756	0.599756	0
Axial 2 permanent def. (mm)	0.586325	0.586325	0.586325	0.586325	0.586325	0.586325	0
Actuator permanent def. (mm)	0.600733	0.600733	0.600733	0.600733	0.600733	0.600733	0
Sequence Number	12						
Cycle Number	196	197	198	199	200	Average	Std Dev.
Resilient Modulus (MPa)	265.369926	266.191947	265.369926	264.569256	266.191947	265.538601	0.68012
Resilient micro-strain	463.980464	457.875458	463.980464	470.08547	457.875458	462.759463	5.107815
Confining pressure (kPa)	40.14652	40.14652	40.43956	40.43956	40.43956	40.322344	0.160505
Maximum axial stress (kPa)	125.613865	124.370163	126.857566	126.857566	124.370163	125.613865	1.243702
Cyclic stress (kPa)	123.126461	121.88276	123.126461	124.370163	121.88276	122.877721	1.040555
Contact stress (kPa)	2.487403	2.487403	3.731105	2.487403	2.487403	2.736144	0.5562
Permanent strain (%)	0.286752	0.286752	0.287363	0.286752	0.286752	0.286874	0.000273
Maximum load (kN)	0.986569	0.976801	0.996337	0.996337	0.976801	0.986569	0.009768
Cyclic load (kN)	0.967033	0.957265	0.967033	0.976801	0.957265	0.965079	0.008173
Contact load (kN)	0.019536	0.019536	0.029304	0.019536	0.019536	0.02149	0.004368
Average resilient def. (mm)	0.092796	0.091575	0.092796	0.094017	0.091575	0.092552	0.001022
Axial 1 resilient def. (mm)	0.090354	0.090354	0.090354	0.092796	0.090354	0.090842	0.001092
Axial 2 resilient def. (mm)	0.095238	0.092796	0.095238	0.095238	0.092796	0.094261	0.001338
Actuator resilient def. (mm)	0.139194	0.139194	0.14652	0.14652	0.14652	0.14359	0.004013
Average permanent def. (mm)	0.573504	0.573504	0.574725	0.573504	0.573504	0.573748	0.000546
Axial 1 permanent def. (mm)	0.577778	0.577778	0.58022	0.577778	0.577778	0.578266	0.001092
Axial 2 permanent def. (mm)	0.569231	0.569231	0.569231	0.569231	0.569231	0.569231	0
Actuator permanent def. (mm)	0.593407	0.593407	0.593407	0.593407	0.593407	0.593407	0
Sequence Number	13						
Cycle Number	196	197	198	199	200	Average	Std Dev.
Resilient Modulus (MPa)	247.596121	244.461993	247.596121	243.844664	240.205192	244.740818	3.072387
Resilient micro-strain	396.825397	396.825397	396.825397	402.930403	409.035409	400.4884	5.460483
Confining pressure (kPa)	30.47619	30.769231	30.18315	30.18315	30.47619	30.417582	0.245175
Maximum axial stress (kPa)	100.739832	99.49613	100.739832	100.739832	100.739832	100.491092	0.5562
Cyclic stress (kPa)	98.252429	97.008727	98.252429	98.252429	98.252429	98.003689	0.5562
Contact stress (kPa)	2.487403	2.487403	2.487403	2.487403	2.487403	2.487403	0
Permanent strain (%)	0.283089	0.283089	0.283089	0.283089	0.283089	0.283089	0
Maximum load (kN)	0.791209	0.781441	0.791209	0.791209	0.791209	0.789255	0.004368
Cyclic load (kN)	0.771673	0.761905	0.771673	0.771673	0.771673	0.769719	0.004368
Contact load (kN)	0.019536	0.019536	0.019536	0.019536	0.019536	0.019536	0

Average resilient def. (mm)	0.079365	0.079365	0.079365	0.080586	0.081807	0.080098	0.001092
Axial 1 resilient def. (mm)	0.078144	0.078144	0.078144	0.080586	0.080586	0.079121	0.001338
Axial 2 resilient def. (mm)	0.080586	0.080586	0.080586	0.080586	0.083028	0.081074	0.001092
Actuator resilient def. (mm)	0.124542	0.124542	0.124542	0.124542	0.131868	0.126007	0.003276
Average permanent def. (mm)	0.566178	0.566178	0.566178	0.566178	0.566178	0.566178	0
Axial 1 permanent def. (mm)	0.570452	0.570452	0.570452	0.570452	0.570452	0.570452	0
Axial 2 permanent def. (mm)	0.561905	0.561905	0.561905	0.561905	0.561905	0.561905	0
Actuator permanent def. (mm)	0.586081	0.586081	0.586081	0.586081	0.586081	0.586081	0
Sequence Number	14						
Cycle Number	196	197	198	199	200	Average	Std Dev.
Resilient Modulus (MPa)	279.520495	282.808972	286.175745	280.990796	285.205658	282.940333	2.788944
Resilient micro-strain	525.030525	518.925519	512.820513	531.135531	518.925519	521.367521	6.960778
Confining pressure (kPa)	40.43956	40.43956	40.43956	40.43956	40.43956	40.43956	0
Maximum axial stress (kPa)	150.487897	150.487897	149.244196	151.731599	150.487897	150.487897	0.87943
Cyclic stress (kPa)	146.756792	146.756792	146.756792	149.244196	148.000494	147.503013	1.112401
Contact stress (kPa)	3.731105	3.731105	2.487403	2.487403	2.487403	2.984884	0.681203
Permanent strain (%)	0.285531	0.285531	0.286142	0.285531	0.285531	0.285653	0.000273
Maximum load (kN)	1.181929	1.181929	1.172161	1.191697	1.181929	1.181929	0.006907
Cyclic load (kN)	1.152625	1.152625	1.152625	1.172161	1.162393	1.158486	0.008737
Contact load (kN)	0.029304	0.029304	0.019536	0.019536	0.019536	0.023443	0.00535
Average resilient def. (mm)	0.105006	0.103785	0.102564	0.106227	0.103785	0.104274	0.001392
Axial 1 resilient def. (mm)	0.102564	0.102564	0.100122	0.105006	0.102564	0.102564	0.001727
Axial 2 resilient def. (mm)	0.107448	0.105006	0.105006	0.107448	0.105006	0.105983	0.001338
Actuator resilient def. (mm)	0.168498	0.168498	0.161172	0.168498	0.168498	0.167033	0.003276
Average permanent def. (mm)	0.571062	0.571062	0.572283	0.571062	0.571062	0.571306	0.000546
Axial 1 permanent def. (mm)	0.575336	0.575336	0.577778	0.575336	0.575336	0.575824	0.001092
Axial 2 permanent def. (mm)	0.566789	0.566789	0.566789	0.566789	0.566789	0.566789	0
Actuator permanent def. (mm)	0.593407	0.593407	0.593407	0.593407	0.593407	0.593407	0
Sequence Number	15						
Cycle Number	196	197	198	199	200	Average	Std Dev.
Resilient Modulus (MPa)	309.495151	312.499958	318.688076	308.487753	308.487753	311.531738	4.325217
Resilient micro-strain	634.920635	628.815629	616.605617	641.025641	641.025641	632.478632	10.215629
Confining pressure (kPa)	50.10989	50.695971	50.40293	50.40293	49.81685	50.285714	0.334117
Maximum axial stress (kPa)	200.235963	200.235963	200.235963	201.479664	201.479664	200.733443	0.681203
Cyclic stress (kPa)	196.504858	196.504858	196.504858	197.748559	197.748559	197.002338	0.681203
Contact stress (kPa)	3.731105	3.731105	3.731105	3.731105	3.731105	3.731105	0
Permanent strain (%)	0.288584	0.288584	0.289194	0.288584	0.288584	0.288706	0.000273
Maximum load (kN)	1.57265	1.57265	1.57265	1.582418	1.582418	1.576557	0.00535
Cyclic load (kN)	1.543346	1.543346	1.543346	1.553114	1.553114	1.547253	0.00535
Contact load (kN)	0.029304	0.029304	0.029304	0.029304	0.029304	0.029304	0
Average resilient def. (mm)	0.126984	0.125763	0.123321	0.128205	0.128205	0.126496	0.002043
Axial 1 resilient def. (mm)	0.124542	0.1221	0.119658	0.124542	0.124542	0.123077	0.002184
Axial 2 resilient def. (mm)	0.129426	0.129426	0.126984	0.131868	0.131868	0.129915	0.002043
Actuator resilient def. (mm)	0.205128	0.205128	0.197802	0.205128	0.212454	0.205128	0.00518
Average permanent def. (mm)	0.577167	0.577167	0.578388	0.577167	0.577167	0.577411	0.000546
Axial 1 permanent def. (mm)	0.582662	0.582662	0.585104	0.582662	0.582662	0.58315	0.001092
Axial 2 permanent def. (mm)	0.571673	0.571673	0.571673	0.571673	0.571673	0.571673	0
Actuator permanent def. (mm)	0.593407	0.593407	0.593407	0.593407	0.593407	0.593407	0
Sequence Number	16						
Cycle Number	196	197	198	199	200	Average	Std Dev.
Resilient Modulus (MPa)	360.307788	364.548585	361.828074	358.005001	356.507073	360.239304	3.163086
Resilient micro-strain	818.070818	811.965812	818.070818	830.28083	830.28083	821.733822	8.190725
Confining pressure (kPa)	75.604396	75.604396	75.311355	75.311355	75.604396	75.487179	0.160505
Maximum axial stress (kPa)	299.732093	300.975795	300.975795	300.975795	300.975795	300.727054	0.5562
Cyclic stress (kPa)	294.757287	296.000988	296.000988	297.24469	296.000988	296.000988	0.87943
Contact stress (kPa)	4.974807	4.974807	4.974807	3.731105	4.974807	4.726066	0.5562
Permanent strain (%)	0.29652	0.297741	0.297131	0.297131	0.297131	0.297131	0.000432
Maximum load (kN)	2.35409	2.363858	2.363858	2.363858	2.363858	2.361905	0.004368
Cyclic load (kN)	2.315018	2.324786	2.324786	2.334554	2.324786	2.324786	0.006907
Contact load (kN)	0.039072	0.039072	0.039072	0.029304	0.039072	0.037118	0.004368
Average resilient def. (mm)	0.163614	0.162393	0.163614	0.166056	0.166056	0.164347	0.001638
Axial 1 resilient def. (mm)	0.15873	0.156288	0.15873	0.161172	0.161172	0.159219	0.002043
Axial 2 resilient def. (mm)	0.168498	0.168498	0.168498	0.17094	0.17094	0.169475	0.001338
Actuator resilient def. (mm)	0.271062	0.271062	0.278388	0.285714	0.271062	0.275458	0.006553
Average permanent def. (mm)	0.59304	0.595482	0.594261	0.594261	0.594261	0.594261	0.000863
Axial 1 permanent def. (mm)	0.599756	0.602198	0.599756	0.599756	0.599756	0.600244	0.001092
Axial 2 permanent def. (mm)	0.586325	0.588767	0.588767	0.588767	0.588767	0.588278	0.001092
Actuator permanent def. (mm)	0.593407	0.600733	0.593407	0.593407	0.600733	0.596337	0.004013
Sequence Number	17						
Cycle Number	196	197	198	199	200	Average	Std Dev.
Resilient Modulus (MPa)	399.844667	399.891531	403.616936	406.155407	402.343696	402.370447	2.664815
Resilient micro-strain	982.905983	989.010989	976.800977	970.695971	976.800977	979.242979	6.960778
Confining pressure (kPa)	100.21978	100.512821	100.21978	99.92674	100.512821	100.278388	0.245175
Maximum axial stress (kPa)	399.228224	400.471925	399.228224	400.471925	399.228224	399.725704	0.681203
Cyclic stress (kPa)	393.009715	395.497119	394.253417	394.253417	393.009715	394.004677	1.040555
Contact stress (kPa)	6.218508	4.974807	4.974807	6.218508	6.218508	5.721028	0.681203
Permanent strain (%)	0.312393	0.312393	0.313004	0.314835	0.313614	0.313248	0.001022

Maximum load (kN)	3.135531	3.145299	3.135531	3.145299	3.135531	3.139438	0.00535
Cyclic load (kN)	3.086691	3.106227	3.096459	3.096459	3.086691	3.094505	0.008173
Contact load (kN)	0.04884	0.039072	0.039072	0.04884	0.04884	0.044933	0.00535
Average resilient def. (mm)	0.196581	0.197802	0.19536	0.194139	0.19536	0.195849	0.001392
Axial 1 resilient def. (mm)	0.190476	0.190476	0.188034	0.188034	0.188034	0.189011	0.001338
Axial 2 resilient def. (mm)	0.202686	0.205128	0.202686	0.200244	0.202686	0.202686	0.001727
Actuator resilient def. (mm)	0.32967	0.336996	0.32967	0.32967	0.32967	0.331136	0.003276
Average permanent def. (mm)	0.624786	0.624786	0.626007	0.62967	0.627228	0.626496	0.002043
Axial 1 permanent def. (mm)	0.631502	0.631502	0.633944	0.636386	0.633944	0.633455	0.002043
Axial 2 permanent def. (mm)	0.618071	0.618071	0.618071	0.622955	0.620513	0.619536	0.002184
Actuator permanent def. (mm)	0.630037	0.630037	0.630037	0.637363	0.630037	0.631502	0.003276
Sequence Number	18						
Cycle Number	196	197	198	199	200	Average	Std Dev.
Resilient Modulus (MPa)	421.29591	433.792857	432.69742	430.360141	428.006858	429.230637	4.964014
Resilient micro-strain	1171.978022	1135.347985	1135.347985	1141.514042	1153.601954	1147.557998	15.552855
Confining pressure (kPa)	125.421245	125.421245	125.421245	125.421245	125.714286	125.479853	0.131052
Maximum axial stress (kPa)	501.211757	498.724354	498.724354	498.724354	501.211757	499.719315	1.362407
Cyclic stress (kPa)	493.749548	492.505846	491.262144	491.262144	493.749548	492.505846	1.243702
Contact stress (kPa)	7.46221	6.218508	7.46221	7.46221	7.46221	7.213469	0.5562
Permanent strain (%)	0.364286	0.365507	0.365507	0.365507	0.365507	0.365263	0.000546
Maximum load (kN)	3.936508	3.916972	3.916972	3.916972	3.936508	3.924786	0.0107
Cyclic load (kN)	3.8779	3.868132	3.858364	3.858364	3.8779	3.868132	0.009768
Contact load (kN)	0.058608	0.04884	0.058608	0.058608	0.058608	0.056654	0.004368
Average resilient def. (mm)	0.234396	0.22707	0.22707	0.228303	0.23072	0.229512	0.003111
Axial 1 resilient def. (mm)	0.226325	0.219048	0.219048	0.219048	0.223883	0.22147	0.003428
Axial 2 resilient def. (mm)	0.242466	0.235092	0.235092	0.237558	0.237558	0.237553	0.003011
Actuator resilient def. (mm)	0.410256	0.388278	0.388278	0.388278	0.40293	0.395604	0.010361
Average permanent def. (mm)	0.728571	0.731013	0.731013	0.731013	0.731013	0.730525	0.001092
Axial 1 permanent def. (mm)	0.734066	0.736508	0.736508	0.736508	0.736508	0.73602	0.001092
Axial 2 permanent def. (mm)	0.723077	0.725519	0.725519	0.725519	0.725519	0.725031	0.001092
Actuator permanent def. (mm)	0.717949	0.725275	0.725275	0.725275	0.725275	0.72381	0.003276
Sequence Number	19						
Cycle Number	196	197	198	199	200	Average	Std Dev.
Resilient Modulus (MPa)	347.347076	347.347076	348.812675	343.864978	351.340303	347.742422	2.712811
Resilient micro-strain	848.595849	848.595849	848.595849	860.805861	842.490842	849.81685	6.687699
Confining pressure (kPa)	75.311355	75.604396	75.311355	75.311355	75.311355	75.369963	0.131052
Maximum axial stress (kPa)	299.732093	299.732093	300.975795	300.975795	300.975795	300.478314	0.681203
Cyclic stress (kPa)	294.757287	294.757287	296.000988	296.000988	296.000988	295.503508	0.681203
Contact stress (kPa)	4.974807	4.974807	4.974807	4.974807	4.974807	4.974807	0
Permanent strain (%)	0.355128	0.355128	0.355128	0.355128	0.355739	0.35525	0.000273
Maximum load (kN)	2.35409	2.35409	2.363858	2.363858	2.363858	2.359951	0.00535
Cyclic load (kN)	2.315018	2.315018	2.324786	2.324786	2.324786	2.320879	0.00535
Contact load (kN)	0.039072	0.039072	0.039072	0.039072	0.039072	0.039072	0
Average resilient def. (mm)	0.169719	0.169719	0.169719	0.172161	0.168498	0.169963	0.001338
Axial 1 resilient def. (mm)	0.166056	0.166056	0.166056	0.168498	0.166056	0.166545	0.001092
Axial 2 resilient def. (mm)	0.173382	0.173382	0.173382	0.175824	0.17094	0.173382	0.001727
Actuator resilient def. (mm)	0.285714	0.278388	0.278388	0.285714	0.278388	0.281319	0.004013
Average permanent def. (mm)	0.710256	0.710256	0.710256	0.710256	0.711477	0.710501	0.000546
Axial 1 permanent def. (mm)	0.71453	0.71453	0.71453	0.71453	0.71453	0.71453	0
Axial 2 permanent def. (mm)	0.705983	0.705983	0.705983	0.705983	0.708425	0.706471	0.001092
Actuator permanent def. (mm)	0.717949	0.717949	0.717949	0.717949	0.717949	0.717949	0
Sequence Number	20						
Cycle Number	196	197	198	199	200	Average	Std Dev.
Resilient Modulus (MPa)	248.989067	258.565569	258.565569	258.565569	248.989067	254.734968	5.245266
Resilient micro-strain	494.505495	476.190476	476.190476	476.190476	494.505495	483.516484	10.031549
Confining pressure (kPa)	30.47619	30.769231	30.47619	30.47619	30.47619	30.534799	0.131052
Maximum axial stress (kPa)	125.613865	125.613865	125.613865	125.613865	125.613865	125.613865	0
Cyclic stress (kPa)	123.126461	123.126461	123.126461	123.126461	123.126461	123.126461	0
Contact stress (kPa)	2.487403	2.487403	2.487403	2.487403	2.487403	2.487403	0
Permanent strain (%)	0.342308	0.343529	0.343529	0.343529	0.342308	0.34304	0.000669
Maximum load (kN)	0.986569	0.986569	0.986569	0.986569	0.986569	0.986569	0
Cyclic load (kN)	0.967033	0.967033	0.967033	0.967033	0.967033	0.967033	0
Contact load (kN)	0.019536	0.019536	0.019536	0.019536	0.019536	0.019536	0
Average resilient def. (mm)	0.098901	0.095238	0.095238	0.095238	0.098901	0.096703	0.002006
Axial 1 resilient def. (mm)	0.09768	0.095238	0.095238	0.095238	0.09768	0.096215	0.001338
Axial 2 resilient def. (mm)	0.100122	0.095238	0.095238	0.095238	0.100122	0.097192	0.002675
Actuator resilient def. (mm)	0.14652	0.14652	0.14652	0.153846	0.153846	0.149451	0.004013
Average permanent def. (mm)	0.684615	0.687057	0.687057	0.687057	0.684615	0.686081	0.001338
Axial 1 permanent def. (mm)	0.687668	0.69011	0.69011	0.69011	0.687668	0.689133	0.001338
Axial 2 permanent def. (mm)	0.681563	0.684005	0.684005	0.684005	0.681563	0.683028	0.001338
Actuator permanent def. (mm)	0.710623	0.710623	0.710623	0.710623	0.710623	0.710623	0
Sequence Number	21						
Cycle Number	196	197	198	199	200	Average	Std Dev.
Resilient Modulus (MPa)	237.16462	236.672762	229.910684	233.242722	233.242722	234.046702	2.958759
Resilient micro-strain	409.035409	415.140415	427.350427	421.245421	421.245421	418.803419	6.960778
Confining pressure (kPa)	20.512821	20.512821	20.512821	20.21978	20.512821	20.454212	0.131052
Maximum axial stress (kPa)	99.49613	100.739832	100.739832	100.739832	100.739832	100.491092	0.5562

Cyclic stress (kPa)	97.008727	98.252429	98.252429	98.252429	98.252429	98.003689	0.5562
Contact stress (kPa)	2.487403	2.487403	2.487403	2.487403	2.487403	2.487403	0
Permanent strain (%)	0.339255	0.339255	0.338645	0.339255	0.338034	0.338889	0.000546
Maximum load (kN)	0.781441	0.791209	0.791209	0.791209	0.791209	0.789255	0.004368
Cyclic load (kN)	0.761905	0.771673	0.771673	0.771673	0.771673	0.769719	0.004368
Contact load (kN)	0.019536	0.019536	0.019536	0.019536	0.019536	0.019536	0
Average resilient def. (mm)	0.081807	0.083028	0.08547	0.084249	0.084249	0.083761	0.001392
Axial 1 resilient def. (mm)	0.083028	0.08547	0.08547	0.08547	0.08547	0.084982	0.001092
Axial 2 resilient def. (mm)	0.080586	0.080586	0.08547	0.083028	0.083028	0.08254	0.002043
Actuator resilient def. (mm)	0.124542	0.124542	0.131868	0.124542	0.131868	0.127473	0.004013
Average permanent def. (mm)	0.67851	0.67851	0.677289	0.67851	0.676068	0.677778	0.001092
Axial 1 permanent def. (mm)	0.680342	0.680342	0.680342	0.680342	0.6779	0.679853	0.001092
Axial 2 permanent def. (mm)	0.676679	0.676679	0.674237	0.676679	0.674237	0.675702	0.001338
Actuator permanent def. (mm)	0.710623	0.710623	0.710623	0.710623	0.703297	0.709158	0.003276
Sequence Number	22						
Cycle Number	196	197	198	199	200	Average	Std Dev.
Resilient Modulus (MPa)	269.360899	272.387426	273.167757	276.307616	262.862358	270.817211	5.087625
Resilient micro-strain	549.450549	543.345543	537.240537	531.135531	567.765568	545.787546	14.05478
Confining pressure (kPa)	30.47619	30.47619	30.47619	30.47619	30.47619	30.47619	0
Maximum axial stress (kPa)	151.731599	151.731599	150.487897	150.487897	151.731599	151.234118	0.681203
Cyclic stress (kPa)	148.000494	148.000494	146.756792	146.756792	149.244196	147.751754	1.040555
Contact stress (kPa)	3.731105	3.731105	3.731105	3.731105	2.487403	3.482365	0.5562
Permanent strain (%)	0.342308	0.342308	0.341697	0.342308	0.341087	0.341941	0.000546
Maximum load (kN)	1.191697	1.191697	1.181929	1.181929	1.191697	1.18779	0.00535
Cyclic load (kN)	1.162393	1.162393	1.152625	1.152625	1.172161	1.16044	0.008173
Contact load (kN)	0.029304	0.029304	0.029304	0.029304	0.019536	0.02735	0.004368
Average resilient def. (mm)	0.10989	0.108669	0.107448	0.106227	0.113553	0.109158	0.002811
Axial 1 resilient def. (mm)	0.10989	0.107448	0.107448	0.105006	0.112332	0.108425	0.002784
Axial 2 resilient def. (mm)	0.10989	0.10989	0.107448	0.107448	0.114774	0.10989	0.002991
Actuator resilient def. (mm)	0.175824	0.175824	0.175824	0.168498	0.175824	0.174359	0.003276
Average permanent def. (mm)	0.684615	0.684615	0.683394	0.684615	0.682173	0.683883	0.001092
Axial 1 permanent def. (mm)	0.687668	0.687668	0.685226	0.687668	0.685226	0.686691	0.001338
Axial 2 permanent def. (mm)	0.681563	0.681563	0.681563	0.681563	0.679121	0.681074	0.001092
Actuator permanent def. (mm)	0.710623	0.710623	0.703297	0.710623	0.710623	0.709158	0.003276
Sequence Number	23						
Cycle Number	196	197	198	199	200	Average	Std Dev.
Resilient Modulus (MPa)	302.721626	300.817717	302.721626	300.817717	300.817717	301.579281	1.042814
Resilient micro-strain	653.235653	653.235653	653.235653	653.235653	653.235653	653.235653	0
Confining pressure (kPa)	40.43956	40.43956	40.43956	40.43956	40.43956	40.43956	0
Maximum axial stress (kPa)	200.235963	200.235963	201.479664	200.235963	200.235963	200.484703	0.5562
Cyclic stress (kPa)	197.748559	196.504858	197.748559	196.504858	196.504858	197.002338	0.681203
Contact stress (kPa)	2.487403	3.731105	3.731105	3.731105	3.731105	3.482365	0.5562
Permanent strain (%)	0.34475	0.34475	0.34475	0.34475	0.34475	0.34475	0
Maximum load (kN)	1.57265	1.57265	1.582418	1.57265	1.57265	1.574603	0.004368
Cyclic load (kN)	1.553114	1.543346	1.553114	1.543346	1.543346	1.547253	0.00535
Contact load (kN)	0.019536	0.029304	0.029304	0.029304	0.029304	0.02735	0.004368
Average resilient def. (mm)	0.130647	0.130647	0.130647	0.130647	0.130647	0.130647	0
Axial 1 resilient def. (mm)	0.129426	0.129426	0.129426	0.129426	0.129426	0.129426	0
Axial 2 resilient def. (mm)	0.131868	0.131868	0.131868	0.131868	0.131868	0.131868	0
Actuator resilient def. (mm)	0.205128	0.205128	0.205128	0.205128	0.205128	0.205128	0
Average permanent def. (mm)	0.689499	0.689499	0.689499	0.689499	0.689499	0.689499	0
Axial 1 permanent def. (mm)	0.692552	0.692552	0.692552	0.692552	0.692552	0.692552	0
Axial 2 permanent def. (mm)	0.686447	0.686447	0.686447	0.686447	0.686447	0.686447	0
Actuator permanent def. (mm)	0.710623	0.710623	0.710623	0.710623	0.710623	0.710623	0
Sequence Number	24						
Cycle Number	196	197	198	199	200	Average	Std Dev.
Resilient Modulus (MPa)	325.292168	327.936819	322.006388	321.060084	325.292168	324.317525	2.7817
Resilient micro-strain	757.020757	750.915751	757.020757	763.125763	757.020757	757.020757	4.316891
Confining pressure (kPa)	50.40293	50.40293	50.40293	50.989011	50.10989	50.461538	0.32101
Maximum axial stress (kPa)	249.984028	249.984028	248.740326	249.984028	249.984028	249.735288	0.5562
Cyclic stress (kPa)	246.252923	246.252923	243.76552	245.009221	246.252923	245.506702	1.112401
Contact stress (kPa)	3.731105	3.731105	4.974807	4.974807	3.731105	4.228586	0.681203
Permanent strain (%)	0.347192	0.348413	0.347192	0.347192	0.347192	0.347436	0.000546
Maximum load (kN)	1.96337	1.96337	1.953602	1.96337	1.96337	1.961416	0.004368
Cyclic load (kN)	1.934066	1.934066	1.91453	1.924298	1.934066	1.928205	0.008737
Contact load (kN)	0.029304	0.029304	0.039072	0.039072	0.029304	0.033211	0.00535
Average resilient def. (mm)	0.151404	0.150183	0.151404	0.152625	0.151404	0.151404	0.000863
Axial 1 resilient def. (mm)	0.148962	0.148962	0.148962	0.151404	0.148962	0.149451	0.001092
Axial 2 resilient def. (mm)	0.153846	0.151404	0.153846	0.153846	0.153846	0.153358	0.001092
Actuator resilient def. (mm)	0.241758	0.249084	0.241758	0.241758	0.249084	0.244689	0.004013
Average permanent def. (mm)	0.694383	0.696825	0.694383	0.694383	0.694383	0.694872	0.001092
Axial 1 permanent def. (mm)	0.697436	0.699878	0.697436	0.697436	0.697436	0.697924	0.001092
Axial 2 permanent def. (mm)	0.691331	0.693773	0.691331	0.691331	0.691331	0.691819	0.001092
Actuator permanent def. (mm)	0.717949	0.717949	0.717949	0.717949	0.717949	0.717949	0
Sequence Number	25						
Cycle Number	196	197	198	199	200	Average	Std Dev.
Resilient Modulus (MPa)	383.035852	389.279009	389.136712	378.246706	381.746169	384.28889	4.82043

Appendix C: Red Sand Stabilisation

Resilient micro-strain	964.346764	952.075702	946.031746	976.556777	964.346764	960.671551	11.911835
Confining pressure (kPa)	75.311355	75.311355	75.604396	75.311355	75.604396	75.428571	0.160505
Maximum axial stress (kPa)	374.354191	375.597893	374.354191	375.597893	374.354191	374.851672	0.681203
Cyclic stress (kPa)	369.379384	370.623086	368.135683	369.379384	368.135683	369.130644	1.040555
Contact stress (kPa)	4.974807	4.974807	6.218508	6.218508	6.218508	5.721028	0.681203
Permanent strain (%)	0.35757	0.358181	0.358181	0.35757	0.35757	0.357814	0.000334
Maximum load (kN)	2.940171	2.949939	2.940171	2.949939	2.940171	2.944078	0.00535
Cyclic load (kN)	2.901099	2.910867	2.891331	2.901099	2.891331	2.899145	0.008173
Contact load (kN)	0.039072	0.039072	0.04884	0.04884	0.04884	0.044933	0.00535
Average resilient def. (mm)	0.192869	0.190415	0.189206	0.195311	0.192869	0.192134	0.002382
Axial 1 resilient def. (mm)	0.18779	0.18779	0.185372	0.190208	0.18779	0.18779	0.001709
Axial 2 resilient def. (mm)	0.197949	0.19304	0.19304	0.200415	0.197949	0.196479	0.003296
Actuator resilient def. (mm)	0.322344	0.322344	0.315018	0.32967	0.322344	0.322344	0.00518
Average permanent def. (mm)	0.71514	0.716361	0.716361	0.71514	0.71514	0.715629	0.000669
Axial 1 permanent def. (mm)	0.719414	0.719414	0.719414	0.719414	0.719414	0.719414	0
Axial 2 permanent def. (mm)	0.710867	0.713309	0.713309	0.710867	0.710867	0.711844	0.001338
Actuator permanent def. (mm)	0.725275	0.725275	0.732601	0.725275	0.725275	0.72674	0.003276
Sequence Number	26						
Cycle Number	196	197	198	199	200	Average	Std Dev.
Resilient Modulus (MPa)	436.138063	426.826143	427.984209	430.383159	433.792857	431.024886	3.908107
Resilient micro-strain	1129.242979	1159.70696	1153.663004	1141.452991	1135.347985	1143.882784	12.640488
Confining pressure (kPa)	100.512821	100.512821	100.512821	100.512821	100.512821	100.512821	0
Maximum axial stress (kPa)	499.968056	502.455459	501.211757	498.724354	498.724354	500.216796	1.621589
Cyclic stress (kPa)	492.505846	494.993249	493.749548	491.262144	492.505846	493.003327	1.418038
Contact stress (kPa)	7.46221	7.46221	7.46221	7.46221	6.218508	7.213469	0.5562
Permanent strain (%)	0.386874	0.386874	0.386874	0.386874	0.386264	0.386752	0.000273
Maximum load (kN)	3.92674	3.946276	3.936508	3.916972	3.916972	3.928694	0.012736
Cyclic load (kN)	3.868132	3.887668	3.8779	3.858364	3.868132	3.872039	0.011137
Contact load (kN)	0.058608	0.058608	0.058608	0.058608	0.04884	0.056654	0.004368
Average resilient def. (mm)	0.225849	0.231941	0.230733	0.228291	0.22707	0.228777	0.002528
Axial 1 resilient def. (mm)	0.218632	0.225885	0.223468	0.22105	0.221074	0.222022	0.002754
Axial 2 resilient def. (mm)	0.233065	0.237998	0.237998	0.235531	0.233065	0.235531	0.002466
Actuator resilient def. (mm)	0.395604	0.410256	0.40293	0.388278	0.395604	0.398535	0.008353
Average permanent def. (mm)	0.773748	0.773748	0.773748	0.773748	0.772527	0.773504	0.000546
Axial 1 permanent def. (mm)	0.778022	0.778022	0.778022	0.778022	0.77558	0.777534	0.001092
Axial 2 permanent def. (mm)	0.769475	0.769475	0.769475	0.769475	0.769475	0.769475	0
Actuator permanent def. (mm)	0.769231	0.769231	0.769231	0.776557	0.769231	0.770696	0.003276
Sequence Number	27						
Cycle Number	196	197	198	199	200	Average	Std Dev.
Resilient Modulus (MPa)	318.638432	322.818958	322.818958	321.847786	318.638432	320.952513	2.149342
Resilient micro-strain	768.925519	762.820513	762.820513	768.986569	768.925519	766.495726	3.355088
Confining pressure (kPa)	50.40293	50.40293	50.695971	50.40293	50.40293	50.461538	0.131052
Maximum axial stress (kPa)	249.984028	249.984028	249.984028	251.227729	249.984028	250.232768	0.5562
Cyclic stress (kPa)	245.009221	246.252923	246.252923	247.496625	245.009221	246.004183	1.040555
Contact stress (kPa)	4.974807	3.731105	3.731105	3.731105	4.974807	4.228586	0.681203
Permanent strain (%)	0.374054	0.374664	0.374664	0.374664	0.374054	0.37442	0.000334
Maximum load (kN)	1.96337	1.96337	1.96337	1.973138	1.96337	1.965324	0.004368
Cyclic load (kN)	1.924298	1.934066	1.934066	1.943834	1.924298	1.932112	0.008173
Contact load (kN)	0.039072	0.029304	0.029304	0.029304	0.039072	0.033211	0.00535
Average resilient def. (mm)	0.153785	0.152564	0.152564	0.153797	0.153785	0.153299	0.000671
Axial 1 resilient def. (mm)	0.151209	0.151209	0.151209	0.151209	0.151209	0.151209	0
Axial 2 resilient def. (mm)	0.156361	0.153919	0.153919	0.156386	0.156361	0.155389	0.001342
Actuator resilient def. (mm)	0.249084	0.249084	0.249084	0.25641	0.249084	0.250549	0.003276
Average permanent def. (mm)	0.748107	0.749328	0.749328	0.749328	0.748107	0.74884	0.000669
Axial 1 permanent def. (mm)	0.75116	0.75116	0.75116	0.75116	0.75116	0.75116	0
Axial 2 permanent def. (mm)	0.745055	0.747497	0.747497	0.747497	0.745055	0.74652	0.001338
Actuator permanent def. (mm)	0.761905	0.761905	0.761905	0.761905	0.761905	0.761905	0
Sequence Number	28						
Cycle Number	196	197	198	199	200	Average	Std Dev.
Resilient Modulus (MPa)	272.905684	278.15387	280.854393	282.832241	272.905684	277.530374	4.536606
Resilient micro-strain	647.130647	634.920635	628.815629	628.815629	647.130647	637.362637	9.2587
Confining pressure (kPa)	30.47619	30.47619	30.47619	30.47619	30.47619	30.47619	0
Maximum axial stress (kPa)	180.336736	180.336736	180.336736	180.336736	179.093035	180.087996	0.5562
Cyclic stress (kPa)	176.605632	176.605632	176.605632	177.849333	176.605632	176.854372	0.5562
Contact stress (kPa)	3.731105	3.731105	3.731105	2.487403	2.487403	3.233624	0.681203
Permanent strain (%)	0.367949	0.368559	0.368559	0.368559	0.367338	0.368193	0.000546
Maximum load (kN)	1.416361	1.416361	1.416361	1.416361	1.406593	1.414408	0.004368
Cyclic load (kN)	1.387057	1.387057	1.387057	1.396825	1.387057	1.389011	0.004368
Contact load (kN)	0.029304	0.029304	0.029304	0.019536	0.019536	0.025397	0.00535
Average resilient def. (mm)	0.129426	0.126984	0.125763	0.125763	0.129426	0.127473	0.001852
Axial 1 resilient def. (mm)	0.126984	0.126984	0.124542	0.124542	0.129426	0.126496	0.002043
Axial 2 resilient def. (mm)	0.131868	0.126984	0.126984	0.126984	0.129426	0.128449	0.002184
Actuator resilient def. (mm)	0.205128	0.205128	0.197802	0.205128	0.205128	0.203663	0.003276
Average permanent def. (mm)	0.735897	0.737118	0.737118	0.737118	0.734676	0.736386	0.001092
Axial 1 permanent def. (mm)	0.73895	0.73895	0.73895	0.73895	0.736508	0.738462	0.001092
Axial 2 permanent def. (mm)	0.732845	0.735287	0.735287	0.735287	0.732845	0.73431	0.001338
Actuator permanent def. (mm)	0.761905	0.761905	0.761905	0.761905	0.761905	0.761905	0

Appendix C: Red Sand Stabilisation

Sequence Number	29						
Cycle Number	196	197	198	199	200	Average	Std Dev.
Resilient Modulus (MPa)	343.50904	343.533585	347.87568	347.472066	339.150545	344.308183	3.555877
Resilient micro-strain	854.456654	854.395604	854.456654	848.290598	872.771673	856.874237	9.276858
Confining pressure (kPa)	50.10989	50.10989	50.40293	50.40293	50.10989	50.227106	0.160505
Maximum axial stress (kPa)	298.488391	298.488391	300.975795	299.732093	300.975795	299.732093	1.243702
Cyclic stress (kPa)	293.513585	293.513585	297.24469	294.757287	296.000988	295.006027	1.621589
Contact stress (kPa)	4.974807	4.974807	3.731105	4.974807	4.974807	4.726066	0.5562
Permanent strain (%)	0.374664	0.374054	0.374664	0.374664	0.374054	0.37442	0.000334
Maximum load (kN)	2.344322	2.344322	2.363858	2.35409	2.363858	2.35409	0.009768
Cyclic load (kN)	2.30525	2.30525	2.334554	2.315018	2.324786	2.316972	0.012736
Contact load (kN)	0.039072	0.039072	0.029304	0.039072	0.039072	0.037118	0.004368
Average resilient def. (mm)	0.170891	0.170879	0.170891	0.169658	0.174554	0.171375	0.001855
Axial 1 resilient def. (mm)	0.168132	0.168132	0.168132	0.168132	0.170549	0.168615	0.001081
Axial 2 resilient def. (mm)	0.173651	0.173626	0.173651	0.171184	0.178559	0.174134	0.002693
Actuator resilient def. (mm)	0.278388	0.278388	0.278388	0.278388	0.29304	0.281319	0.006553
Average permanent def. (mm)	0.749328	0.748107	0.749328	0.749328	0.748107	0.74884	0.000669
Axial 1 permanent def. (mm)	0.75116	0.75116	0.75116	0.75116	0.75116	0.75116	0
Axial 2 permanent def. (mm)	0.747497	0.745055	0.747497	0.747497	0.745055	0.74652	0.001338
Actuator permanent def. (mm)	0.769231	0.769231	0.769231	0.769231	0.769231	0.769231	0
Sequence Number	30						
Cycle Number	196	197	198	199	200	Average	Std Dev.
Resilient Modulus (MPa)	407.504951	414.516029	412.160289	410.982385	414.516029	411.935937	2.911485
Resilient micro-strain	1092.612943	1068.131868	1074.236874	1080.34188	1068.131868	1076.691087	10.239353
Confining pressure (kPa)	75.311355	75.311355	75.311355	75.311355	75.311355	75.311355	0
Maximum axial stress (kPa)	451.463692	448.976289	448.976289	450.21999	448.976289	449.72251	1.112401
Cyclic stress (kPa)	445.245184	442.757781	442.757781	444.001482	442.757781	443.504002	1.112401
Contact stress (kPa)	6.218508	6.218508	6.218508	6.218508	6.218508	6.218508	0
Permanent strain (%)	0.388095	0.388706	0.388095	0.388706	0.388706	0.388462	0.000334
Maximum load (kN)	3.545788	3.526252	3.526252	3.53602	3.526252	3.532112	0.008737
Cyclic load (kN)	3.496947	3.477411	3.477411	3.487179	3.477411	3.483272	0.008737
Contact load (kN)	0.04884	0.04884	0.04884	0.04884	0.04884	0.04884	0
Average resilient def. (mm)	0.218523	0.213626	0.214847	0.216068	0.213626	0.215338	0.002048
Axial 1 resilient def. (mm)	0.213797	0.208938	0.21138	0.211355	0.208938	0.210882	0.002033
Axial 2 resilient def. (mm)	0.223248	0.218315	0.218315	0.220781	0.218315	0.219795	0.002206
Actuator resilient def. (mm)	0.373626	0.3663	0.3663	0.373626	0.358974	0.367766	0.006129
Average permanent def. (mm)	0.77619	0.777411	0.77619	0.777411	0.777411	0.776923	0.000669
Axial 1 permanent def. (mm)	0.778022	0.780464	0.778022	0.780464	0.780464	0.779487	0.001338
Axial 2 permanent def. (mm)	0.774359	0.774359	0.774359	0.774359	0.774359	0.774359	0
Actuator permanent def. (mm)	0.783883	0.783883	0.783883	0.783883	0.783883	0.783883	0
Sequence Number	31						
Cycle Number	196	197	198	199	200	Average	Std Dev.
Resilient Modulus (MPa)	336.794678	341.539602	335.379574	337.725542	336.794678	337.646815	2.331986
Resilient micro-strain	878.876679	866.666667	878.876679	872.771673	878.876679	875.213675	5.460483
Confining pressure (kPa)	50.10989	50.40293	50.40293	50.40293	50.40293	50.344322	0.131052
Maximum axial stress (kPa)	300.975795	299.732093	299.732093	299.732093	300.975795	300.229574	0.681203
Cyclic stress (kPa)	296.000988	296.000988	294.757287	294.757287	296.000988	295.503508	0.681203
Contact stress (kPa)	4.974807	3.731105	4.974807	4.974807	4.974807	4.726066	0.5562
Permanent strain (%)	0.38199	0.38199	0.38199	0.382601	0.38199	0.382112	0.000273
Maximum load (kN)	2.363858	2.35409	2.35409	2.35409	2.363858	2.357998	0.00535
Cyclic load (kN)	2.324786	2.324786	2.315018	2.315018	2.324786	2.320879	0.00535
Contact load (kN)	0.039072	0.029304	0.039072	0.039072	0.039072	0.037118	0.004368
Average resilient def. (mm)	0.175775	0.173333	0.175775	0.174554	0.175775	0.175043	0.001092
Axial 1 resilient def. (mm)	0.172821	0.170403	0.172821	0.172821	0.172821	0.172337	0.001081
Axial 2 resilient def. (mm)	0.17873	0.176264	0.17873	0.176288	0.17873	0.177748	0.001344
Actuator resilient def. (mm)	0.29304	0.285714	0.285714	0.285714	0.285714	0.287179	0.003276
Average permanent def. (mm)	0.76398	0.76398	0.76398	0.765201	0.76398	0.764225	0.000546
Axial 1 permanent def. (mm)	0.765812	0.765812	0.765812	0.765812	0.765812	0.765812	0
Axial 2 permanent def. (mm)	0.762149	0.762149	0.762149	0.764591	0.762149	0.762637	0.001092
Actuator permanent def. (mm)	0.783883	0.783883	0.791209	0.791209	0.791209	0.788278	0.004013
Sequence Number	32						
Cycle Number	196	197	198	199	200	Average	Std Dev.
Resilient Modulus (MPa)	278.15387	275.504785	269.763133	275.504785	277.44496	275.274307	3.297078
Resilient micro-strain	634.920635	641.025641	659.279609	641.025641	641.025641	643.455433	9.232538
Confining pressure (kPa)	30.18315	30.18315	30.769231	30.18315	30.769231	30.417582	0.32101
Maximum axial stress (kPa)	180.336736	180.336736	181.580438	180.336736	180.336736	180.585477	0.5562
Cyclic stress (kPa)	176.605632	176.605632	177.849333	176.605632	177.849333	177.103112	0.681203
Contact stress (kPa)	3.731105	3.731105	3.731105	3.731105	2.487403	3.482365	0.5562
Permanent strain (%)	0.376496	0.375885	0.375885	0.375885	0.375885	0.376007	0.000273
Maximum load (kN)	1.416361	1.416361	1.426129	1.416361	1.416361	1.418315	0.004368
Cyclic load (kN)	1.387057	1.387057	1.396825	1.387057	1.396825	1.390965	0.00535
Contact load (kN)	0.029304	0.029304	0.029304	0.029304	0.019536	0.02735	0.004368
Average resilient def. (mm)	0.126984	0.128205	0.131856	0.128205	0.128205	0.128691	0.001847
Axial 1 resilient def. (mm)	0.126984	0.126984	0.131844	0.126984	0.126984	0.127956	0.002173
Axial 2 resilient def. (mm)	0.126984	0.129426	0.131868	0.129426	0.129426	0.129426	0.001727
Actuator resilient def. (mm)	0.197802	0.197802	0.212454	0.205128	0.197802	0.202198	0.006553
Average permanent def. (mm)	0.752991	0.75177	0.75177	0.75177	0.75177	0.752015	0.000546
Axial 1 permanent def. (mm)	0.753602	0.753602	0.753602	0.753602	0.753602	0.753602	0

Axial 2 permanent def. (mm)	0.752381	0.749939	0.749939	0.749939	0.749939	0.750427	0.001092
Actuator permanent def. (mm)	0.783883	0.776557	0.776557	0.776557	0.776557	0.778022	0.003276
Sequence Number	33						
Cycle Number	196	197	198	199	200	Average	Std Dev.
Resilient Modulus (MPa)	320.23046	314.385011	309.583407	319.312753	315.225295	315.747385	4.270043
Resilient micro-strain	768.986569	787.240537	799.450549	775.091575	781.196581	782.393162	11.714662
Confining pressure (kPa)	40.732601	40.14652	40.43956	40.43956	40.43956	40.43956	0.207211
Maximum axial stress (kPa)	249.984028	251.227729	251.227729	251.227729	249.984028	250.730249	0.681203
Cyclic stress (kPa)	246.252923	247.496625	247.496625	247.496625	246.252923	246.999144	0.681203
Contact stress (kPa)	3.731105	3.731105	3.731105	3.731105	3.731105	3.731105	0
Permanent strain (%)	0.379548	0.378327	0.378327	0.378938	0.378327	0.378694	0.000546
Maximum load (kN)	1.96337	1.973138	1.973138	1.973138	1.96337	1.969231	0.00535
Cyclic load (kN)	1.934066	1.943834	1.943834	1.943834	1.934066	1.939927	0.00535
Contact load (kN)	0.029304	0.029304	0.029304	0.029304	0.029304	0.029304	0
Average resilient def. (mm)	0.153797	0.157448	0.15989	0.155018	0.156239	0.156479	0.002343
Axial 1 resilient def. (mm)	0.151111	0.155971	0.158388	0.151111	0.153553	0.154027	0.003163
Axial 2 resilient def. (mm)	0.156484	0.158926	0.161392	0.158926	0.158926	0.15893	0.001735
Actuator resilient def. (mm)	0.249084	0.25641	0.25641	0.249084	0.249084	0.252015	0.004013
Average permanent def. (mm)	0.759096	0.756654	0.756654	0.757875	0.756654	0.757387	0.001092
Axial 1 permanent def. (mm)	0.760928	0.758486	0.758486	0.760928	0.758486	0.759463	0.001338
Axial 2 permanent def. (mm)	0.757265	0.754823	0.754823	0.754823	0.754823	0.755311	0.001092
Actuator permanent def. (mm)	0.776557	0.776557	0.776557	0.776557	0.776557	0.776557	0
Sequence Number	34						
Cycle Number	196	197	198	199	200	Average	Std Dev.
Resilient Modulus (MPa)	290.901758	294.165295	294.165295	294.165295	291.628512	293.005231	1.60913
Resilient micro-strain	713.980464	701.831502	701.831502	701.831502	707.936508	705.482295	5.43661
Confining pressure (kPa)	30.47619	30.18315	30.47619	30.47619	30.47619	30.417582	0.131052
Maximum axial stress (kPa)	211.429277	210.185576	210.185576	210.185576	210.185576	210.434316	0.5562
Cyclic stress (kPa)	207.698172	206.454471	206.454471	206.454471	206.454471	206.703211	0.5562
Contact stress (kPa)	3.731105	3.731105	3.731105	3.731105	3.731105	3.731105	0
Permanent strain (%)	0.375885	0.375885	0.375885	0.375885	0.375885	0.375885	0
Maximum load (kN)	1.660562	1.650794	1.650794	1.650794	1.650794	1.652747	0.004368
Cyclic load (kN)	1.631258	1.62149	1.62149	1.62149	1.62149	1.623443	0.004368
Contact load (kN)	0.029304	0.029304	0.029304	0.029304	0.029304	0.029304	0
Average resilient def. (mm)	0.142796	0.140366	0.140366	0.140366	0.141587	0.141096	0.001087
Axial 1 resilient def. (mm)	0.141514	0.139096	0.139096	0.139096	0.139096	0.13958	0.001081
Axial 2 resilient def. (mm)	0.144078	0.141636	0.141636	0.141636	0.144078	0.142613	0.001338
Actuator resilient def. (mm)	0.234432	0.21978	0.21978	0.21978	0.227106	0.224176	0.006553
Average permanent def. (mm)	0.75177	0.75177	0.75177	0.75177	0.75177	0.75177	0
Axial 1 permanent def. (mm)	0.753602	0.753602	0.753602	0.753602	0.753602	0.753602	0
Axial 2 permanent def. (mm)	0.749939	0.749939	0.749939	0.749939	0.749939	0.749939	0
Actuator permanent def. (mm)	0.769231	0.776557	0.769231	0.776557	0.769231	0.772161	0.004013
Sequence Number	35						
Cycle Number	196	197	198	199	200	Average	Std Dev.
Resilient Modulus (MPa)	333.618009	336.083535	336.083535	336.108625	332.638045	334.90635	1.659972
Resilient micro-strain	823.870574	817.826618	817.826618	817.765568	830.03663	821.465201	5.463998
Confining pressure (kPa)	40.14652	40.43956	40.43956	40.43956	40.43956	40.380952	0.131052
Maximum axial stress (kPa)	279.832867	279.832867	279.832867	279.832867	279.832867	279.832867	0
Cyclic stress (kPa)	274.85806	274.85806	274.85806	274.85806	276.101762	275.106801	0.5562
Contact stress (kPa)	4.974807	4.974807	4.974807	4.974807	3.731105	4.726066	0.5562
Permanent strain (%)	0.379548	0.379548	0.379548	0.378938	0.378327	0.379182	0.000546
Maximum load (kN)	2.197802	2.197802	2.197802	2.197802	2.197802	2.197802	0
Cyclic load (kN)	2.15873	2.15873	2.15873	2.15873	2.168498	2.160684	0.004368
Contact load (kN)	0.039072	0.039072	0.039072	0.039072	0.029304	0.037118	0.004368
Average resilient def. (mm)	0.164774	0.163565	0.163565	0.163553	0.166007	0.164293	0.001093
Axial 1 resilient def. (mm)	0.163199	0.160781	0.160781	0.160781	0.163223	0.161753	0.001331
Axial 2 resilient def. (mm)	0.166349	0.166349	0.166349	0.166325	0.168791	0.166833	0.001095
Actuator resilient def. (mm)	0.263736	0.263736	0.271062	0.263736	0.263736	0.265201	0.003276
Average permanent def. (mm)	0.759096	0.759096	0.759096	0.757875	0.756654	0.758364	0.001092
Axial 1 permanent def. (mm)	0.760928	0.760928	0.760928	0.760928	0.758486	0.76044	0.001092
Axial 2 permanent def. (mm)	0.757265	0.757265	0.757265	0.754823	0.754823	0.756288	0.001338
Actuator permanent def. (mm)	0.783883	0.783883	0.783883	0.783883	0.783883	0.783883	0
Sequence Number	36						
Cycle Number	196	197	198	199	200	Average	Std Dev.
Resilient Modulus (MPa)	370.251667	375.156962	370.006964	371.347569	368.919826	371.136598	2.407337
Resilient micro-strain	933.821734	921.611722	927.716728	927.716728	933.821734	928.937729	5.107815
Confining pressure (kPa)	50.40293	50.40293	50.10989	50.10989	50.40293	50.285714	0.160505
Maximum axial stress (kPa)	351.967562	350.72386	349.480158	349.480158	349.480158	350.226379	1.112401
Cyclic stress (kPa)	345.749053	345.749053	343.26165	344.505352	344.505352	344.754092	1.040555
Contact stress (kPa)	6.218508	4.974807	6.218508	4.974807	4.974807	5.472287	0.681203
Permanent strain (%)	0.383822	0.383822	0.383211	0.383211	0.383822	0.383578	0.000334
Maximum load (kN)	2.764347	2.754579	2.744811	2.744811	2.744811	2.750672	0.008737
Cyclic load (kN)	2.715507	2.715507	2.695971	2.705739	2.705739	2.707692	0.008173
Contact load (kN)	0.04884	0.039072	0.04884	0.039072	0.039072	0.042979	0.00535
Average resilient def. (mm)	0.186764	0.184322	0.185543	0.185543	0.186764	0.185788	0.001022
Axial 1 resilient def. (mm)	0.182442	0.180024	0.182466	0.182466	0.182442	0.181968	0.001087
Axial 2 resilient def. (mm)	0.191087	0.18862	0.18862	0.18862	0.191087	0.189607	0.001351

Actuator resilient def. (mm)	0.315018	0.307692	0.315018	0.307692	0.315018	0.312088	0.004013
Average permanent def. (mm)	0.767643	0.767643	0.766422	0.766422	0.767643	0.767155	0.000669
Axial 1 permanent def. (mm)	0.770696	0.770696	0.768254	0.768254	0.770696	0.769719	0.001338
Axial 2 permanent def. (mm)	0.764591	0.764591	0.764591	0.764591	0.764591	0.764591	0
Actuator permanent def. (mm)	0.783883	0.783883	0.783883	0.783883	0.783883	0.783883	0
Sequence Number	37						
Cycle Number	196	197	198	199	200	Average	Std Dev.
Resilient Modulus (MPa)	436.884339	439.17098	438.115281	436.884339	429.10816	436.03262	3.987035
Resilient micro-strain	1184.249084	1178.083028	1178.083028	1184.249084	1208.608059	1186.654457	12.653765
Confining pressure (kPa)	75.018315	75.311355	75.604396	75.604396	75.311355	75.369963	0.245175
Maximum axial stress (kPa)	524.842088	524.842088	523.598387	524.842088	526.08579	524.842088	0.87943
Cyclic stress (kPa)	517.379878	517.379878	516.136177	517.379878	518.62358	517.379878	0.87943
Contact stress (kPa)	7.46221	7.46221	7.46221	7.46221	7.46221	7.46221	0
Permanent strain (%)	0.408852	0.408852	0.408852	0.408852	0.408242	0.40873	0.000273
Maximum load (kN)	4.1221	4.1221	4.112332	4.1221	4.131868	4.1221	0.006907
Cyclic load (kN)	4.063492	4.063492	4.053724	4.063492	4.07326	4.063492	0.006907
Contact load (kN)	0.058608	0.058608	0.058608	0.058608	0.058608	0.058608	0
Average resilient def. (mm)	0.23685	0.235617	0.235617	0.23685	0.241722	0.237331	0.002531
Axial 1 resilient def. (mm)	0.230305	0.230305	0.230305	0.230305	0.23514	0.231272	0.002162
Axial 2 resilient def. (mm)	0.243394	0.240928	0.240928	0.243394	0.248303	0.243389	0.003011
Actuator resilient def. (mm)	0.410256	0.40293	0.40293	0.40293	0.417582	0.407326	0.006553
Average permanent def. (mm)	0.817705	0.817705	0.817705	0.817705	0.816484	0.81746	0.000546
Axial 1 permanent def. (mm)	0.819536	0.819536	0.819536	0.819536	0.819536	0.819536	0
Axial 2 permanent def. (mm)	0.815873	0.815873	0.815873	0.815873	0.813431	0.815385	0.001092
Actuator permanent def. (mm)	0.820513	0.827839	0.827839	0.827839	0.827839	0.826374	0.003276
Sequence Number	38						
Cycle Number	196	197	198	199	200	Average	Std Dev.
Resilient Modulus (MPa)	323.990719	324.014036	326.362815	323.154474	323.990719	324.302553	1.208355
Resilient micro-strain	848.351648	848.290598	842.185592	854.395604	848.351648	848.315018	4.317021
Confining pressure (kPa)	40.14652	40.43956	40.14652	40.14652	40.43956	40.263736	0.160505
Maximum axial stress (kPa)	279.832867	279.832867	279.832867	281.076569	279.832867	280.081607	0.5562
Cyclic stress (kPa)	274.85806	274.85806	274.85806	276.101762	274.85806	275.106801	0.5562
Contact stress (kPa)	4.974807	4.974807	4.974807	4.974807	4.974807	4.974807	0
Permanent strain (%)	0.398474	0.399084	0.398474	0.399695	0.398474	0.39884	0.000546
Maximum load (kN)	2.197802	2.197802	2.197802	2.20757	2.197802	2.199756	0.004368
Cyclic load (kN)	2.15873	2.15873	2.15873	2.168498	2.15873	2.160684	0.004368
Contact load (kN)	0.039072	0.039072	0.039072	0.039072	0.039072	0.039072	0
Average resilient def. (mm)	0.16967	0.169658	0.168437	0.170879	0.16967	0.169663	0.000863
Axial 1 resilient def. (mm)	0.167668	0.167643	0.167668	0.170061	0.167668	0.168142	0.001073
Axial 2 resilient def. (mm)	0.171673	0.171673	0.169206	0.171697	0.171673	0.171184	0.001106
Actuator resilient def. (mm)	0.271062	0.271062	0.271062	0.278388	0.271062	0.272527	0.003276
Average permanent def. (mm)	0.796947	0.798168	0.796947	0.799389	0.796947	0.79768	0.001092
Axial 1 permanent def. (mm)	0.797558	0.8	0.797558	0.8	0.797558	0.798535	0.001338
Axial 2 permanent def. (mm)	0.796337	0.796337	0.796337	0.798779	0.796337	0.796825	0.001092
Actuator permanent def. (mm)	0.827839	0.827839	0.827839	0.827839	0.827839	0.827839	0
Sequence Number	39						
Cycle Number	196	197	198	199	200	Average	Std Dev.
Resilient Modulus (MPa)	255.318388	255.894854	258.648188	258.648188	247.498529	255.20163	4.571364
Resilient micro-strain	579.67033	573.504274	567.399267	567.399267	597.985348	577.191697	12.687592
Confining pressure (kPa)	20.21978	20.512821	20.512821	20.512821	20.21978	20.395604	0.160505
Maximum axial stress (kPa)	150.487897	150.487897	150.487897	150.487897	151.731599	150.736638	0.5562
Cyclic stress (kPa)	148.000494	146.756792	146.756792	146.756792	148.000494	147.254273	0.681203
Contact stress (kPa)	2.487403	3.731105	3.731105	3.731105	3.731105	3.482365	0.5562
Permanent strain (%)	0.391758	0.391758	0.392369	0.392369	0.391148	0.39188	0.000511
Maximum load (kN)	1.181929	1.181929	1.181929	1.181929	1.191697	1.183883	0.004368
Cyclic load (kN)	1.162393	1.152625	1.152625	1.152625	1.162393	1.156532	0.00535
Contact load (kN)	0.019536	0.029304	0.029304	0.029304	0.029304	0.02735	0.004368
Average resilient def. (mm)	0.115934	0.114701	0.11348	0.11348	0.119597	0.115438	0.002538
Axial 1 resilient def. (mm)	0.114603	0.114603	0.114603	0.114603	0.119463	0.115575	0.002173
Axial 2 resilient def. (mm)	0.117265	0.114799	0.112357	0.112357	0.119731	0.115302	0.003205
Actuator resilient def. (mm)	0.175824	0.175824	0.175824	0.175824	0.18315	0.177289	0.003276
Average permanent def. (mm)	0.783516	0.783516	0.784737	0.784737	0.782295	0.783761	0.001022
Axial 1 permanent def. (mm)	0.785348	0.785348	0.785348	0.785348	0.782906	0.78486	0.001092
Axial 2 permanent def. (mm)	0.781685	0.781685	0.784127	0.784127	0.781685	0.782662	0.001338
Actuator permanent def. (mm)	0.813187	0.813187	0.813187	0.813187	0.813187	0.813187	0
Sequence Number	40						
Cycle Number	196	197	198	199	200	Average	Std Dev.
Resilient Modulus (MPa)	316.272051	309.709627	311.31434	311.31434	308.857107	311.493493	2.873652
Resilient micro-strain	762.881563	775.030525	775.030525	775.030525	781.196581	773.833944	6.679418
Confining pressure (kPa)	30.18315	30.47619	30.18315	30.47619	30.47619	30.358974	0.160505
Maximum axial stress (kPa)	245.009221	245.009221	245.009221	245.009221	246.252923	245.257962	0.5562
Cyclic stress (kPa)	241.278116	240.034415	241.278116	241.278116	241.278116	241.029376	0.5562
Contact stress (kPa)	3.731105	4.974807	3.731105	3.731105	4.974807	4.228586	0.681203
Permanent strain (%)	0.396032	0.395421	0.395421	0.395421	0.395421	0.395543	0.000273
Maximum load (kN)	1.924298	1.924298	1.924298	1.924298	1.934066	1.926252	0.004368
Cyclic load (kN)	1.894994	1.885226	1.894994	1.894994	1.894994	1.89304	0.004368
Contact load (kN)	0.029304	0.039072	0.029304	0.029304	0.039072	0.033211	0.00535

Average resilient def. (mm)	0.152576	0.155006	0.155006	0.155006	0.156239	0.154767	0.001336
Axial 1 resilient def. (mm)	0.150794	0.153211	0.153211	0.153211	0.153211	0.152728	0.001081
Axial 2 resilient def. (mm)	0.154359	0.156801	0.156801	0.156801	0.159267	0.156806	0.001735
Actuator resilient def. (mm)	0.241758	0.249084	0.249084	0.241758	0.249084	0.246154	0.004013
Average permanent def. (mm)	0.792063	0.790842	0.790842	0.790842	0.790842	0.791087	0.000546
Axial 1 permanent def. (mm)	0.792674	0.792674	0.792674	0.792674	0.792674	0.792674	0
Axial 2 permanent def. (mm)	0.791453	0.789011	0.789011	0.789011	0.789011	0.789499	0.001092
Actuator permanent def. (mm)	0.820513	0.813187	0.813187	0.820513	0.813187	0.816117	0.004013
Sequence Number	41						
Cycle Number	196	197	198	199	200	Average	Std Dev.
Resilient Modulus (MPa)	355.226605	353.849757	358.698343	350.488986	354.18572	354.489882	2.948022
Resilient micro-strain	903.296703	903.296703	891.086691	915.506716	909.462759	904.529915	9.063457
Confining pressure (kPa)	40.43956	40.43956	40.732601	40.43956	40.14652	40.43956	0.207211
Maximum axial stress (kPa)	325.849827	324.606126	325.849827	325.849827	327.093529	325.849827	0.87943
Cyclic stress (kPa)	320.875021	319.631319	319.631319	320.875021	322.118722	320.62628	1.040555
Contact stress (kPa)	4.974807	4.974807	6.218508	4.974807	4.974807	5.223547	0.5562
Permanent strain (%)	0.399084	0.400305	0.400305	0.399084	0.399084	0.399573	0.000669
Maximum load (kN)	2.559219	2.549451	2.559219	2.559219	2.568987	2.559219	0.006907
Cyclic load (kN)	2.520147	2.510379	2.510379	2.520147	2.529915	2.518193	0.008173
Contact load (kN)	0.039072	0.039072	0.04884	0.039072	0.039072	0.041026	0.004368
Average resilient def. (mm)	0.180659	0.180659	0.178217	0.183101	0.181893	0.180906	0.001813
Axial 1 resilient def. (mm)	0.177314	0.177289	0.174872	0.179731	0.177314	0.177304	0.001718
Axial 2 resilient def. (mm)	0.184005	0.184029	0.181563	0.186471	0.186471	0.184508	0.002053
Actuator resilient def. (mm)	0.29304	0.300366	0.29304	0.29304	0.300366	0.295971	0.004013
Average permanent def. (mm)	0.798168	0.800611	0.800611	0.798168	0.798168	0.799145	0.001338
Axial 1 permanent def. (mm)	0.8	0.802442	0.802442	0.8	0.8	0.800977	0.001338
Axial 2 permanent def. (mm)	0.796337	0.798779	0.798779	0.796337	0.796337	0.797314	0.001338
Actuator permanent def. (mm)	0.820513	0.820513	0.820513	0.820513	0.813187	0.819048	0.003276
Sequence Number	42						
Cycle Number	196	197	198	199	200	Average	Std Dev.
Resilient Modulus (MPa)	384.488627	385.54825	386.76834	382.190387	386.76834	385.152789	1.910061
Resilient micro-strain	1025.396825	1019.352869	1019.352869	1031.562882	1019.352869	1023.003663	5.453722
Confining pressure (kPa)	50.10989	50.695971	50.40293	50.40293	50.40293	50.40293	0.207211
Maximum axial stress (kPa)	399.228224	399.228224	399.228224	400.471925	399.228224	399.476964	0.5562
Cyclic stress (kPa)	394.253417	393.009715	394.253417	394.253417	394.253417	394.004677	0.5562
Contact stress (kPa)	4.974807	6.218508	4.974807	6.218508	4.974807	5.472287	0.681203
Permanent strain (%)	0.403968	0.403968	0.403968	0.403968	0.403968	0.403968	0
Maximum load (kN)	3.135531	3.135531	3.135531	3.145299	3.135531	3.137485	0.004368
Cyclic load (kN)	3.096459	3.086691	3.096459	3.096459	3.096459	3.094505	0.004368
Contact load (kN)	0.039072	0.04884	0.039072	0.04884	0.039072	0.042979	0.00535
Average resilient def. (mm)	0.205079	0.203871	0.203871	0.206313	0.203871	0.204601	0.001091
Axial 1 resilient def. (mm)	0.201392	0.198974	0.198974	0.201392	0.198974	0.199941	0.001324
Axial 2 resilient def. (mm)	0.208767	0.208767	0.208767	0.211233	0.208767	0.20926	0.001103
Actuator resilient def. (mm)	0.344322	0.344322	0.344322	0.351648	0.336996	0.344322	0.00518
Average permanent def. (mm)	0.807937	0.807937	0.807937	0.807937	0.807937	0.807937	0
Axial 1 permanent def. (mm)	0.809768	0.809768	0.809768	0.809768	0.809768	0.809768	0
Axial 2 permanent def. (mm)	0.806105	0.806105	0.806105	0.806105	0.806105	0.806105	0
Actuator permanent def. (mm)	0.827839	0.827839	0.827839	0.827839	0.835165	0.829304	0.003276
Sequence Number	43						
Cycle Number	196	197	198	199	200	Average	Std Dev.
Resilient Modulus (MPa)	305.695066	310.473418	310.449154	308.041825	304.103997	307.752692	2.841815
Resilient micro-strain	793.345543	781.135531	781.196581	787.301587	793.406593	787.277167	6.105098
Confining pressure (kPa)	30.47619	30.47619	30.769231	30.47619	29.89011	30.417582	0.32101
Maximum axial stress (kPa)	246.252923	246.252923	246.252923	246.252923	245.009221	246.004183	0.5562
Cyclic stress (kPa)	242.521818	242.521818	242.521818	242.521818	241.278116	242.273078	0.5562
Contact stress (kPa)	3.731105	3.731105	3.731105	3.731105	3.731105	3.731105	0
Permanent strain (%)	0.398474	0.398474	0.399084	0.398474	0.397863	0.398474	0.000432
Maximum load (kN)	1.934066	1.934066	1.934066	1.934066	1.924298	1.932112	0.004368
Cyclic load (kN)	1.904762	1.904762	1.904762	1.904762	1.894994	1.902808	0.004368
Contact load (kN)	0.029304	0.029304	0.029304	0.029304	0.029304	0.029304	0
Average resilient def. (mm)	0.158669	0.156227	0.156239	0.15746	0.158681	0.157455	0.001221
Axial 1 resilient def. (mm)	0.157998	0.15558	0.153138	0.15558	0.15558	0.155575	0.001718
Axial 2 resilient def. (mm)	0.159341	0.156874	0.159341	0.159341	0.161783	0.159336	0.001735
Actuator resilient def. (mm)	0.25641	0.249084	0.241758	0.249084	0.249084	0.249084	0.00518
Average permanent def. (mm)	0.796947	0.796947	0.798168	0.796947	0.795726	0.796947	0.000863
Axial 1 permanent def. (mm)	0.797558	0.797558	0.8	0.797558	0.797558	0.798046	0.001092
Axial 2 permanent def. (mm)	0.796337	0.796337	0.796337	0.796337	0.793895	0.795849	0.001092
Actuator permanent def. (mm)	0.820513	0.820513	0.827839	0.827839	0.820513	0.823443	0.004013
Sequence Number	44						
Cycle Number	196	197	198	199	200	Average	Std Dev.
Resilient Modulus (MPa)	272.365567	272.365567	268.07459	275.550081	270.537346	271.77863	2.746522
Resilient micro-strain	671.245421	671.245421	677.350427	658.974359	671.184371	670	6.710038
Confining pressure (kPa)	20.21978	20.21978	20.512821	20.512821	20.512821	20.395604	0.160505
Maximum axial stress (kPa)	185.311543	186.555245	185.311543	185.311543	185.311543	185.560283	0.5562
Cyclic stress (kPa)	182.82414	182.82414	181.580438	181.580438	181.580438	182.077919	0.681203
Contact stress (kPa)	2.487403	3.731105	3.731105	3.731105	3.731105	3.482365	0.5562
Permanent strain (%)	0.394811	0.394811	0.3942	0.395421	0.3942	0.394689	0.000511

Maximum load (kN)	1.455433	1.465201	1.455433	1.455433	1.455433	1.457387	0.004368
Cyclic load (kN)	1.435897	1.435897	1.426129	1.426129	1.426129	1.430037	0.00535
Contact load (kN)	0.019536	0.029304	0.029304	0.029304	0.029304	0.02735	0.004368
Average resilient def. (mm)	0.134249	0.134249	0.13547	0.131795	0.134237	0.134	0.001342
Axial 1 resilient def. (mm)	0.133895	0.133895	0.133895	0.131453	0.133895	0.133407	0.001092
Axial 2 resilient def. (mm)	0.134603	0.134603	0.137045	0.132137	0.134579	0.134593	0.001735
Actuator resilient def. (mm)	0.212454	0.205128	0.212454	0.197802	0.205128	0.206593	0.006129
Average permanent def. (mm)	0.789621	0.789621	0.7884	0.790842	0.7884	0.789377	0.001022
Axial 1 permanent def. (mm)	0.790232	0.790232	0.790232	0.792674	0.790232	0.79072	0.001092
Axial 2 permanent def. (mm)	0.789011	0.789011	0.786569	0.789011	0.786569	0.788034	0.001338
Actuator permanent def. (mm)	0.813187	0.820513	0.813187	0.820513	0.820513	0.817582	0.004013
Sequence Number	45						
Cycle Number	196	197	198	199	200	Average	Std Dev.
Resilient Modulus (MPa)	326.644567	327.555402	321.93255	322.795743	326.644567	325.114566	2.556445
Resilient micro-strain	830.03663	823.931624	842.185592	836.080586	830.03663	832.454212	6.931347
Confining pressure (kPa)	30.18315	30.47619	30.47619	30.47619	30.47619	30.417582	0.131052
Maximum axial stress (kPa)	274.85806	274.85806	276.101762	274.85806	274.85806	275.106801	0.5562
Cyclic stress (kPa)	271.126956	269.883254	271.126956	269.883254	271.126956	270.629475	0.681203
Contact stress (kPa)	3.731105	4.974807	4.974807	4.974807	3.731105	4.477326	0.681203
Permanent strain (%)	0.399084	0.398474	0.398474	0.397863	0.397863	0.398352	0.000511
Maximum load (kN)	2.15873	2.15873	2.168498	2.15873	2.15873	2.160684	0.004368
Cyclic load (kN)	2.129426	2.119658	2.129426	2.119658	2.129426	2.125519	0.00535
Contact load (kN)	0.029304	0.039072	0.039072	0.039072	0.029304	0.035165	0.00535
Average resilient def. (mm)	0.166007	0.164786	0.168437	0.167216	0.166007	0.166491	0.001386
Axial 1 resilient def. (mm)	0.162808	0.162833	0.167668	0.16525	0.162833	0.164278	0.002166
Axial 2 resilient def. (mm)	0.169206	0.16674	0.169206	0.169182	0.169182	0.168703	0.001098
Actuator resilient def. (mm)	0.271062	0.263736	0.278388	0.271062	0.271062	0.271062	0.00518
Average permanent def. (mm)	0.798168	0.796947	0.796947	0.795726	0.795726	0.796703	0.001022
Axial 1 permanent def. (mm)	0.8	0.797558	0.797558	0.797558	0.797558	0.798046	0.001092
Axial 2 permanent def. (mm)	0.796337	0.796337	0.796337	0.793895	0.793895	0.79536	0.001338
Actuator permanent def. (mm)	0.827839	0.827839	0.827839	0.827839	0.827839	0.827839	0
Sequence Number	46						
Cycle Number	196	197	198	199	200	Average	Std Dev.
Resilient Modulus (MPa)	375.476315	368.544516	375.476315	373.152475	370.834182	372.696761	3.015371
Resilient micro-strain	970.512821	988.766789	970.512821	976.556777	982.661783	977.802198	7.931881
Confining pressure (kPa)	40.14652	40.43956	40.43956	40.43956	40.43956	40.380952	0.131052
Maximum axial stress (kPa)	369.379384	369.379384	369.379384	369.379384	369.379384	369.379384	0
Cyclic stress (kPa)	364.404578	364.404578	364.404578	364.404578	364.404578	364.404578	0
Contact stress (kPa)	4.974807	4.974807	4.974807	4.974807	4.974807	4.974807	0
Permanent strain (%)	0.402747	0.401526	0.402747	0.402747	0.402137	0.402381	0.000546
Maximum load (kN)	2.901099	2.901099	2.901099	2.901099	2.901099	2.901099	0
Cyclic load (kN)	2.862027	2.862027	2.862027	2.862027	2.862027	2.862027	0
Contact load (kN)	0.039072	0.039072	0.039072	0.039072	0.039072	0.039072	0
Average resilient def. (mm)	0.194103	0.197753	0.194103	0.195311	0.196532	0.19556	0.001586
Axial 1 resilient def. (mm)	0.189328	0.194188	0.189328	0.191746	0.194188	0.191756	0.00243
Axial 2 resilient def. (mm)	0.198877	0.201319	0.198877	0.198877	0.198877	0.199365	0.001092
Actuator resilient def. (mm)	0.322344	0.322344	0.322344	0.32967	0.322344	0.32381	0.003276
Average permanent def. (mm)	0.805495	0.803053	0.805495	0.805495	0.804274	0.804762	0.001092
Axial 1 permanent def. (mm)	0.807326	0.804884	0.807326	0.807326	0.804884	0.806349	0.001338
Axial 2 permanent def. (mm)	0.803663	0.801221	0.803663	0.803663	0.803663	0.803175	0.001092
Actuator permanent def. (mm)	0.827839	0.827839	0.827839	0.827839	0.827839	0.827839	0
Sequence Number	47						
Cycle Number	196	197	198	199	200	Average	Std Dev.
Resilient Modulus (MPa)	410.959161	405.240657	409.808015	410.959161	402.976743	407.988748	3.661579
Resilient micro-strain	1080.40293	1098.717949	1080.40293	1080.40293	1098.717949	1087.728938	10.031549
Confining pressure (kPa)	50.40293	50.40293	50.40293	50.40293	50.10989	50.344322	0.131052
Maximum axial stress (kPa)	450.21999	451.463692	448.976289	450.21999	448.976289	449.97125	1.040555
Cyclic stress (kPa)	444.001482	445.245184	442.757781	444.001482	442.757781	443.752742	1.040555
Contact stress (kPa)	6.218508	6.218508	6.218508	6.218508	6.218508	6.218508	0
Permanent strain (%)	0.408852	0.408242	0.408852	0.408852	0.408242	0.408608	0.000334
Maximum load (kN)	3.53602	3.545788	3.526252	3.53602	3.526252	3.534066	0.008173
Cyclic load (kN)	3.487179	3.496947	3.477411	3.487179	3.477411	3.485226	0.008173
Contact load (kN)	0.04884	0.04884	0.04884	0.04884	0.04884	0.04884	0
Average resilient def. (mm)	0.216081	0.219744	0.216081	0.216081	0.219744	0.217546	0.002006
Axial 1 resilient def. (mm)	0.210965	0.215824	0.210965	0.210965	0.215824	0.212908	0.002662
Axial 2 resilient def. (mm)	0.221197	0.223663	0.221197	0.221197	0.223663	0.222183	0.001351
Actuator resilient def. (mm)	0.3663	0.373626	0.3663	0.3663	0.373626	0.369231	0.004013
Average permanent def. (mm)	0.817705	0.816484	0.817705	0.817705	0.816484	0.817216	0.000669
Axial 1 permanent def. (mm)	0.819536	0.817094	0.819536	0.819536	0.817094	0.818559	0.001338
Axial 2 permanent def. (mm)	0.815873	0.815873	0.815873	0.815873	0.815873	0.815873	0
Actuator permanent def. (mm)	0.835165	0.835165	0.835165	0.835165	0.835165	0.835165	0
Sequence Number	48						
Cycle Number	196	197	198	199	200	Average	Std Dev.
Resilient Modulus (MPa)	322.795743	321.284745	322.772174	324.259604	319.569658	322.136385	1.779074
Resilient micro-strain	836.080586	836.141636	836.141636	836.141636	848.412698	838.583639	5.494675
Confining pressure (kPa)	30.47619	30.769231	30.769231	30.769231	30.47619	30.652015	0.160505
Maximum axial stress (kPa)	274.85806	273.614359	273.614359	274.85806	274.85806	274.36058	0.681203

Cyclic stress (kPa)	269.883254	268.639552	269.883254	271.126956	271.126956	270.131994	1.040555
Contact stress (kPa)	4.974807	4.974807	3.731105	3.731105	3.731105	4.228586	0.681203
Permanent strain (%)	0.403968	0.403358	0.403358	0.403358	0.402747	0.403358	0.000432
Maximum load (kN)	2.15873	2.148962	2.148962	2.15873	2.15873	2.154823	0.00535
Cyclic load (kN)	2.119658	2.10989	2.119658	2.129426	2.129426	2.121612	0.008173
Contact load (kN)	0.039072	0.039072	0.029304	0.029304	0.029304	0.033211	0.00535
Average resilient def. (mm)	0.167216	0.167228	0.167228	0.167228	0.169683	0.167717	0.001099
Axial 1 resilient def. (mm)	0.165128	0.162711	0.162711	0.162711	0.165153	0.163683	0.001331
Axial 2 resilient def. (mm)	0.169304	0.171746	0.171746	0.171746	0.174212	0.171751	0.001735
Actuator resilient def. (mm)	0.263736	0.271062	0.271062	0.271062	0.271062	0.269597	0.003276
Average permanent def. (mm)	0.807937	0.806716	0.806716	0.806716	0.805495	0.806716	0.000863
Axial 1 permanent def. (mm)	0.809768	0.809768	0.809768	0.809768	0.807326	0.80928	0.001092
Axial 2 permanent def. (mm)	0.806105	0.803663	0.803663	0.803663	0.803663	0.804151	0.001092
Actuator permanent def. (mm)	0.835165	0.827839	0.827839	0.827839	0.827839	0.829304	0.003276
Sequence Number	49						
Cycle Number	196	197	198	199	200	Average	Std Dev.
Resilient Modulus (MPa)	292.528737	294.931779	292.528737	294.931779	294.931779	293.970562	1.3162
Resilient micro-strain	756.776557	750.610501	756.776557	750.610501	750.610501	753.076923	3.377288
Confining pressure (kPa)	20.21978	20.512821	20.512821	20.512821	20.512821	20.454212	0.131052
Maximum axial stress (kPa)	225.109995	225.109995	225.109995	225.109995	225.109995	225.109995	0
Cyclic stress (kPa)	221.37889	221.37889	221.37889	221.37889	221.37889	221.37889	0
Contact stress (kPa)	3.731105	3.731105	3.731105	3.731105	3.731105	3.731105	0
Permanent strain (%)	0.400305	0.400305	0.400305	0.400305	0.400305	0.400305	0
Maximum load (kN)	1.76801	1.76801	1.76801	1.76801	1.76801	1.76801	0
Cyclic load (kN)	1.738706	1.738706	1.738706	1.738706	1.738706	1.738706	0
Contact load (kN)	0.029304	0.029304	0.029304	0.029304	0.029304	0.029304	0
Average resilient def. (mm)	0.151355	0.150122	0.151355	0.150122	0.150122	0.150615	0.000675
Axial 1 resilient def. (mm)	0.148278	0.148278	0.148278	0.148278	0.148278	0.148278	0
Axial 2 resilient def. (mm)	0.154432	0.151966	0.154432	0.151966	0.151966	0.152952	0.001351
Actuator resilient def. (mm)	0.234432	0.234432	0.241758	0.234432	0.234432	0.235897	0.003276
Average permanent def. (mm)	0.800611	0.800611	0.800611	0.800611	0.800611	0.800611	0
Axial 1 permanent def. (mm)	0.802442	0.802442	0.802442	0.802442	0.802442	0.802442	0
Axial 2 permanent def. (mm)	0.798779	0.798779	0.798779	0.798779	0.798779	0.798779	0
Actuator permanent def. (mm)	0.835165	0.835165	0.827839	0.835165	0.835165	0.8337	0.003276
Sequence Number	50						
Cycle Number	196	197	198	199	200	Average	Std Dev.
Resilient Modulus (MPa)	355.26031	351.945671	355.26031	356.264165	350.645341	353.875159	2.434095
Resilient micro-strain	927.716728	939.98779	927.716728	921.611722	939.92674	931.391941	8.206682
Confining pressure (kPa)	30.47619	30.769231	30.47619	30.47619	30.769231	30.593407	0.160505
Maximum axial stress (kPa)	334.555739	335.79944	334.555739	333.312037	334.555739	334.555739	0.87943
Cyclic stress (kPa)	329.580932	330.824634	329.580932	328.337231	329.580932	329.580932	0.87943
Contact stress (kPa)	4.974807	4.974807	4.974807	4.974807	4.974807	4.974807	0
Permanent strain (%)	0.403968	0.404579	0.403968	0.404579	0.403968	0.404212	0.000334
Maximum load (kN)	2.627595	2.637363	2.627595	2.617827	2.627595	2.627595	0.006907
Cyclic load (kN)	2.588523	2.598291	2.588523	2.578755	2.588523	2.588523	0.006907
Contact load (kN)	0.039072	0.039072	0.039072	0.039072	0.039072	0.039072	0
Average resilient def. (mm)	0.185543	0.187998	0.185543	0.184322	0.187985	0.186278	0.001641
Axial 1 resilient def. (mm)	0.182051	0.182027	0.182051	0.179609	0.184469	0.182042	0.001718
Axial 2 resilient def. (mm)	0.189035	0.193968	0.189035	0.189035	0.191502	0.190515	0.002206
Actuator resilient def. (mm)	0.307692	0.315018	0.300366	0.300366	0.307692	0.306227	0.006129
Average permanent def. (mm)	0.807937	0.809158	0.807937	0.809158	0.807937	0.808425	0.000669
Axial 1 permanent def. (mm)	0.809768	0.81221	0.809768	0.81221	0.809768	0.810745	0.001338
Axial 2 permanent def. (mm)	0.806105	0.806105	0.806105	0.806105	0.806105	0.806105	0
Actuator permanent def. (mm)	0.827839	0.835165	0.835165	0.835165	0.835165	0.8337	0.003276
Sequence Number	51						
Cycle Number	196	197	198	199	200	Average	Std Dev.
Resilient Modulus (MPa)	413.328034	410.979179	407.482439	415.656643	409.808015	411.450862	3.157617
Resilient micro-strain	1068.192918	1074.297924	1086.568987	1068.192918	1080.40293	1075.531136	7.981043
Confining pressure (kPa)	40.43956	40.14652	40.43956	40.14652	40.43956	40.322344	0.160505
Maximum axial stress (kPa)	448.976289	448.976289	448.976289	448.976289	448.976289	448.976289	0
Cyclic stress (kPa)	441.514079	441.514079	442.757781	444.001482	442.757781	442.50904	1.040555
Contact stress (kPa)	7.46221	7.46221	6.218508	4.974807	6.218508	6.467248	1.040555
Permanent strain (%)	0.411294	0.410684	0.410073	0.411294	0.410073	0.410684	0.000611
Maximum load (kN)	3.526252	3.526252	3.526252	3.526252	3.526252	3.526252	0
Cyclic load (kN)	3.467643	3.467643	3.477411	3.487179	3.477411	3.475458	0.008173
Contact load (kN)	0.058608	0.058608	0.04884	0.039072	0.04884	0.050794	0.008173
Average resilient def. (mm)	0.213639	0.21486	0.217314	0.213639	0.216081	0.215106	0.001596
Axial 1 resilient def. (mm)	0.208498	0.21094	0.21094	0.208498	0.21094	0.209963	0.001338
Axial 2 resilient def. (mm)	0.218779	0.218779	0.223687	0.218779	0.221221	0.220249	0.002194
Actuator resilient def. (mm)	0.3663	0.3663	0.373626	0.3663	0.3663	0.367766	0.003276
Average permanent def. (mm)	0.822589	0.821368	0.820147	0.822589	0.820147	0.821368	0.001221
Axial 1 permanent def. (mm)	0.82442	0.821978	0.821978	0.82442	0.821978	0.822955	0.001338
Axial 2 permanent def. (mm)	0.820757	0.820757	0.818315	0.820757	0.818315	0.81978	0.001338
Actuator permanent def. (mm)	0.842491	0.842491	0.835165	0.842491	0.842491	0.841026	0.003276
Sequence Number	52						
Cycle Number	196	197	198	199	200	Average	Std Dev.
Resilient Modulus (MPa)	435.440684	437.735192	437.607482	438.743798	437.585923	437.422616	1.20749

Resilient micro-strain	1245.299145	1233.089133	1239.133089	1233.089133	1239.194139	1237.960928	5.104238
Confining pressure (kPa)	50.40293	50.695971	50.40293	50.40293	50.695971	50.520147	0.160505
Maximum axial stress (kPa)	549.716121	547.228718	548.472419	548.472419	549.716121	548.72116	1.040555
Cyclic stress (kPa)	542.253911	539.766508	542.253911	541.010209	542.253911	541.50769	1.112401
Contact stress (kPa)	7.46221	7.46221	6.218508	7.46221	7.46221	7.213469	0.5562
Permanent strain (%)	0.429609	0.429609	0.429609	0.429609	0.428999	0.429487	0.000273
Maximum load (kN)	4.31746	4.297924	4.307692	4.307692	4.31746	4.309646	0.008173
Cyclic load (kN)	4.258852	4.239316	4.258852	4.249084	4.258852	4.252991	0.008737
Contact load (kN)	0.058608	0.058608	0.04884	0.058608	0.058608	0.056654	0.004368
Average resilient def. (mm)	0.24906	0.246618	0.247827	0.246618	0.247839	0.247592	0.001021
Axial 1 resilient def. (mm)	0.241978	0.23956	0.241978	0.23956	0.242002	0.241016	0.001329
Axial 2 resilient def. (mm)	0.256142	0.253675	0.253675	0.253675	0.253675	0.254168	0.001103
Actuator resilient def. (mm)	0.432234	0.424908	0.432234	0.424908	0.432234	0.429304	0.004013
Average permanent def. (mm)	0.859219	0.859219	0.859219	0.859219	0.857998	0.858974	0.000546
Axial 1 permanent def. (mm)	0.86105	0.86105	0.86105	0.86105	0.858608	0.860562	0.001092
Axial 2 permanent def. (mm)	0.857387	0.857387	0.857387	0.857387	0.857387	0.857387	0
Actuator permanent def. (mm)	0.886447	0.886447	0.886447	0.886447	0.879121	0.884982	0.003276
Sequence Number	53						
Cycle Number	196	197	198	199	200	Average	Std Dev.
Resilient Modulus (MPa)	305.670118	300.384907	308.00419	306.448614	301.838978	304.469361	3.219315
Resilient micro-strain	805.616606	823.931624	799.5116	799.5116	811.721612	808.058608	10.215629
Confining pressure (kPa)	20.512821	20.512821	20.21978	20.512821	19.92674	20.336996	0.262103
Maximum axial stress (kPa)	249.984028	251.227729	249.984028	248.740326	249.984028	249.984028	0.87943
Cyclic stress (kPa)	246.252923	247.496625	246.252923	245.009221	245.009221	246.004183	1.040555
Contact stress (kPa)	3.731105	3.731105	3.731105	3.731105	4.974807	3.979845	0.5562
Permanent strain (%)	0.41862	0.419231	0.419231	0.419231	0.41801	0.418864	0.000546
Maximum load (kN)	1.96337	1.973138	1.96337	1.953602	1.96337	1.96337	0.006907
Cyclic load (kN)	1.934066	1.943834	1.934066	1.924298	1.924298	1.932112	0.008173
Contact load (kN)	0.029304	0.029304	0.029304	0.029304	0.039072	0.031258	0.004368
Average resilient def. (mm)	0.161123	0.164786	0.159902	0.159902	0.162344	0.161612	0.002043
Axial 1 resilient def. (mm)	0.157582	0.162418	0.157582	0.157582	0.160024	0.159038	0.002165
Axial 2 resilient def. (mm)	0.164664	0.167155	0.162222	0.162222	0.164664	0.164186	0.002061
Actuator resilient def. (mm)	0.25641	0.263736	0.249084	0.249084	0.25641	0.254945	0.006129
Average permanent def. (mm)	0.837241	0.838462	0.838462	0.838462	0.83602	0.837729	0.001092
Axial 1 permanent def. (mm)	0.839072	0.839072	0.839072	0.839072	0.83663	0.838584	0.001092
Axial 2 permanent def. (mm)	0.835409	0.837851	0.837851	0.837851	0.835409	0.836874	0.001338
Actuator permanent def. (mm)	0.864469	0.871795	0.871795	0.871795	0.871795	0.87033	0.003276
Sequence Number	54						
Cycle Number	196	197	198	199	200	Average	Std Dev.
Resilient Modulus (MPa)	363.608418	364.549877	364.549877	365.777318	363.586641	364.414427	0.898477
Resilient micro-strain	1019.291819	1013.247863	1013.247863	1013.247863	1019.352869	1015.677656	3.3272
Confining pressure (kPa)	30.47619	30.47619	30.18315	30.47619	30.47619	30.417582	0.131052
Maximum axial stress (kPa)	375.597893	374.354191	374.354191	375.597893	375.597893	375.100412	0.681203
Cyclic stress (kPa)	370.623086	369.379384	369.379384	370.623086	370.623086	370.125605	0.681203
Contact stress (kPa)	4.974807	4.974807	4.974807	4.974807	4.974807	4.974807	0
Permanent strain (%)	0.424115	0.424115	0.424115	0.424115	0.423504	0.423993	0.000273
Maximum load (kN)	2.949939	2.940171	2.940171	2.949939	2.949939	2.946032	0.00535
Cyclic load (kN)	2.910867	2.901099	2.901099	2.910867	2.910867	2.90696	0.00535
Contact load (kN)	0.039072	0.039072	0.039072	0.039072	0.039072	0.039072	0
Average resilient def. (mm)	0.203858	0.20265	0.20265	0.20265	0.203871	0.203136	0.000665
Axial 1 resilient def. (mm)	0.201001	0.198584	0.198584	0.198584	0.198584	0.199067	0.001081
Axial 2 resilient def. (mm)	0.206716	0.206716	0.206716	0.206716	0.209158	0.207204	0.001092
Actuator resilient def. (mm)	0.32967	0.32967	0.336996	0.336996	0.336996	0.334066	0.004013
Average permanent def. (mm)	0.84823	0.84823	0.84823	0.84823	0.847009	0.847985	0.000546
Axial 1 permanent def. (mm)	0.84884	0.84884	0.84884	0.84884	0.84884	0.84884	0
Axial 2 permanent def. (mm)	0.847619	0.847619	0.847619	0.847619	0.845177	0.847131	0.001092
Actuator permanent def. (mm)	0.879121	0.879121	0.871795	0.871795	0.871795	0.874725	0.004013
Sequence Number	55						
Cycle Number	196	197	198	199	200	Average	Std Dev.
Resilient Modulus (MPa)	420.212822	423.586562	418.090535	422.435239	419.173513	420.699734	2.275967
Resilient micro-strain	1172.039072	1159.76801	1172.039072	1165.873016	1171.978022	1168.339438	5.481024
Confining pressure (kPa)	40.14652	40.43956	40.732601	40.43956	40.43956	40.43956	0.207211
Maximum axial stress (kPa)	498.724354	498.724354	497.480652	498.724354	498.724354	498.475614	0.5562
Cyclic stress (kPa)	492.505846	491.262144	490.018443	492.505846	491.262144	491.510885	1.040555
Contact stress (kPa)	6.218508	7.46221	7.46221	6.218508	7.46221	6.964729	0.681203
Permanent strain (%)	0.434493	0.435104	0.434493	0.434493	0.433883	0.434493	0.000432
Maximum load (kN)	3.916972	3.916972	3.907204	3.916972	3.916972	3.915018	0.004368
Cyclic load (kN)	3.868132	3.858364	3.848596	3.868132	3.858364	3.860317	0.008173
Contact load (kN)	0.04884	0.058608	0.058608	0.04884	0.058608	0.054701	0.00535
Average resilient def. (mm)	0.234408	0.231954	0.234408	0.233175	0.234396	0.233668	0.001096
Axial 1 resilient def. (mm)	0.227375	0.227375	0.227375	0.227375	0.229817	0.227863	0.001092
Axial 2 resilient def. (mm)	0.241441	0.236532	0.241441	0.238974	0.238974	0.239473	0.002055
Actuator resilient def. (mm)	0.40293	0.395604	0.40293	0.395604	0.40293	0.4	0.004013
Average permanent def. (mm)	0.868987	0.870208	0.868987	0.868987	0.867766	0.868987	0.000863
Axial 1 permanent def. (mm)	0.870818	0.870818	0.870818	0.870818	0.868376	0.87033	0.001092
Axial 2 permanent def. (mm)	0.867155	0.869597	0.867155	0.867155	0.867155	0.867643	0.001092
Actuator permanent def. (mm)	0.893773	0.893773	0.886447	0.893773	0.886447	0.890842	0.004013

Appendix C: Red Sand Stabilisation

Sequence Number	56						
Cycle Number	196	197	198	199	200	Average	Std Dev.
Resilient Modulus (MPa)	324.656132	321.177543	324.122204	319.828057	324.122204	322.781228	2.145036
Resilient micro-strain	915.567766	921.611722	909.401709	921.611722	909.401709	915.518926	6.105067
Confining pressure (kPa)	20.512821	20.512821	20.512821	20.21978	20.21978	20.395604	0.160505
Maximum axial stress (kPa)	300.975795	300.975795	299.732093	299.732093	299.732093	300.229574	0.681203
Cyclic stress (kPa)	297.24469	296.000988	294.757287	294.757287	294.757287	295.503508	1.112401
Contact stress (kPa)	3.731105	4.974807	4.974807	4.974807	4.974807	4.726066	0.5562
Permanent strain (%)	0.426557	0.426557	0.427778	0.426557	0.426557	0.426801	0.000546
Maximum load (kN)	2.363858	2.363858	2.35409	2.35409	2.35409	2.357998	0.00535
Cyclic load (kN)	2.334554	2.324786	2.315018	2.315018	2.315018	2.320879	0.008737
Contact load (kN)	0.029304	0.039072	0.039072	0.039072	0.039072	0.037118	0.004368
Average resilient def. (mm)	0.183114	0.184322	0.18188	0.184322	0.18188	0.183104	0.001221
Axial 1 resilient def. (mm)	0.179194	0.181612	0.17917	0.181612	0.179194	0.180156	0.001329
Axial 2 resilient def. (mm)	0.187033	0.187033	0.184591	0.187033	0.184567	0.186051	0.001344
Actuator resilient def. (mm)	0.29304	0.29304	0.29304	0.29304	0.300366	0.294505	0.003276
Average permanent def. (mm)	0.853114	0.853114	0.855556	0.853114	0.853114	0.853602	0.001092
Axial 1 permanent def. (mm)	0.853724	0.853724	0.856166	0.853724	0.853724	0.854212	0.001092
Axial 2 permanent def. (mm)	0.852503	0.852503	0.854945	0.852503	0.852503	0.852991	0.001092
Actuator permanent def. (mm)	0.886447	0.886447	0.886447	0.886447	0.886447	0.886447	0
Sequence Number	57						
Cycle Number	196	197	198	199	200	Average	Std Dev.
Resilient Modulus (MPa)	402.954353	401.844786	400.749983	398.525797	395.322296	399.879443	3.028012
Resilient micro-strain	1098.778999	1098.717949	1104.822955	1110.989011	1123.137973	1107.289377	10.208384
Confining pressure (kPa)	30.18315	30.47619	30.18315	30.47619	30.47619	30.358974	0.160505
Maximum axial stress (kPa)	448.976289	448.976289	448.976289	448.976289	450.21999	449.225029	0.5562
Cyclic stress (kPa)	442.757781	441.514079	442.757781	442.757781	444.001482	442.757781	0.87943
Contact stress (kPa)	6.218508	7.46221	6.218508	6.218508	6.218508	6.467248	0.5562
Permanent strain (%)	0.435714	0.435104	0.434493	0.434493	0.433883	0.434737	0.000696
Maximum load (kN)	3.526252	3.526252	3.526252	3.526252	3.53602	3.528205	0.004368
Cyclic load (kN)	3.477411	3.467643	3.477411	3.477411	3.487179	3.477411	0.006907
Contact load (kN)	0.04884	0.058608	0.04884	0.04884	0.04884	0.050794	0.004368
Average resilient def. (mm)	0.219756	0.219744	0.220965	0.222198	0.224628	0.221458	0.002042
Axial 1 resilient def. (mm)	0.212845	0.215287	0.215287	0.215287	0.220147	0.21577	0.002665
Axial 2 resilient def. (mm)	0.226667	0.2242	0.226642	0.229109	0.229109	0.227145	0.002053
Actuator resilient def. (mm)	0.3663	0.3663	0.373626	0.373626	0.380952	0.372161	0.006129
Average permanent def. (mm)	0.871429	0.870208	0.868987	0.868987	0.867766	0.869475	0.001392
Axial 1 permanent def. (mm)	0.87326	0.870818	0.870818	0.870818	0.868376	0.870818	0.001727
Axial 2 permanent def. (mm)	0.869597	0.869597	0.867155	0.867155	0.867155	0.868132	0.001338
Actuator permanent def. (mm)	0.901099	0.901099	0.893773	0.893773	0.893773	0.896703	0.004013
Sequence Number	58						
Cycle Number	196	197	198	199	200	Average	Std Dev.
Resilient Modulus (MPa)	445.460567	442.339575	444.350486	444.350486	447.319512	444.764125	1.819043
Resilient micro-strain	1323.382173	1335.531136	1329.487179	1329.487179	1323.443223	1328.266178	5.071383
Confining pressure (kPa)	40.43956	40.732601	40.43956	40.14652	40.14652	40.380952	0.245175
Maximum axial stress (kPa)	598.220485	598.220485	598.220485	598.220485	599.464186	598.469225	0.5562
Cyclic stress (kPa)	589.514573	590.758275	590.758275	590.758275	592.001976	590.758275	0.87943
Contact stress (kPa)	8.705911	7.46221	7.46221	7.46221	7.46221	7.71095	0.5562
Permanent strain (%)	0.466819	0.466819	0.466819	0.466819	0.467424	0.46694	0.00027
Maximum load (kN)	4.698413	4.698413	4.698413	4.698413	4.708181	4.700366	0.004368
Cyclic load (kN)	4.630037	4.639805	4.639805	4.639805	4.649573	4.639805	0.006907
Contact load (kN)	0.068376	0.058608	0.058608	0.058608	0.058608	0.060562	0.004368
Average resilient def. (mm)	0.264676	0.267106	0.265897	0.265897	0.264689	0.265653	0.001014
Axial 1 resilient def. (mm)	0.258681	0.261099	0.258681	0.258681	0.256264	0.258681	0.001709
Axial 2 resilient def. (mm)	0.270672	0.273114	0.273114	0.273114	0.273114	0.272625	0.001092
Actuator resilient def. (mm)	0.454212	0.461538	0.461538	0.454212	0.454212	0.457143	0.004013
Average permanent def. (mm)	0.933639	0.933639	0.933639	0.933639	0.934847	0.93388	0.000541
Axial 1 permanent def. (mm)	0.933797	0.933797	0.933797	0.933797	0.936215	0.934281	0.001081
Axial 2 permanent def. (mm)	0.93348	0.93348	0.93348	0.93348	0.93348	0.93348	0
Actuator permanent def. (mm)	0.959707	0.959707	0.959707	0.959707	0.959707	0.959707	0
Sequence Number	59						
Cycle Number	196	197	198	199	200	Average	Std Dev.
Resilient Modulus (MPa)	403.706976	404.731613	401.715255	404.731613	401.715255	403.320142	1.523603
Resilient micro-strain	1213.797314	1213.797314	1226.007326	1213.797314	1226.007326	1218.681319	6.687699
Confining pressure (kPa)	30.18315	30.47619	30.47619	30.18315	30.18315	30.300366	0.160505
Maximum axial stress (kPa)	497.480652	498.724354	499.968056	498.724354	498.724354	498.724354	0.87943
Cyclic stress (kPa)	490.018443	491.262144	492.505846	491.262144	492.505846	491.510885	1.040555
Contact stress (kPa)	7.46221	7.46221	7.46221	7.46221	6.218508	7.213469	0.5562
Permanent strain (%)	0.471703	0.471703	0.471087	0.471703	0.470482	0.471336	0.000547
Maximum load (kN)	3.907204	3.916972	3.92674	3.916972	3.916972	3.916972	0.006907
Cyclic load (kN)	3.848596	3.858364	3.868132	3.858364	3.868132	3.860317	0.008173
Contact load (kN)	0.058608	0.058608	0.058608	0.058608	0.04884	0.056654	0.004368
Average resilient def. (mm)	0.242759	0.242759	0.245201	0.242759	0.245201	0.243736	0.001338
Axial 1 resilient def. (mm)	0.236923	0.236923	0.239341	0.236923	0.239341	0.23789	0.001324
Axial 2 resilient def. (mm)	0.248596	0.248596	0.251062	0.248596	0.251062	0.249582	0.001351
Actuator resilient def. (mm)	0.40293	0.40293	0.410256	0.40293	0.40293	0.404396	0.003276
Average permanent def. (mm)	0.943407	0.943407	0.942173	0.943407	0.940965	0.942672	0.001093
Axial 1 permanent def. (mm)	0.943468	0.943468	0.943468	0.943468	0.94105	0.942984	0.001081

Axial 2 permanent def. (mm)	0.943346	0.943346	0.940879	0.943346	0.940879	0.942359	0.001351
Actuator permanent def. (mm)	0.981685	0.981685	0.981685	0.981685	0.981685	0.981685	0
Sequence Number	60						
Cycle Number	196	197	198	199	200	Average	Std Dev.
Resilient Modulus (MPa)	341.146286	338.691996	333.139382	339.919141	331.901992	336.959759	4.16719
Resilient micro-strain	1013.492063	1013.492063	1037.851038	1013.492063	1037.973138	1023.260073	13.375468
Confining pressure (kPa)	20.512821	20.512821	19.6337	20.805861	20.21978	20.336996	0.444418
Maximum axial stress (kPa)	350.72386	349.480158	350.72386	349.480158	350.72386	350.226379	0.681203
Cyclic stress (kPa)	345.749053	343.26165	345.749053	344.505352	344.505352	344.754092	1.040555
Contact stress (kPa)	4.974807	6.218508	4.974807	4.974807	6.218508	5.472287	0.681203
Permanent strain (%)	0.46804	0.46804	0.466819	0.46804	0.466203	0.467429	0.000866
Maximum load (kN)	2.754579	2.744811	2.754579	2.744811	2.754579	2.750672	0.00535
Cyclic load (kN)	2.715507	2.695971	2.715507	2.705739	2.705739	2.707692	0.008173
Contact load (kN)	0.039072	0.04884	0.039072	0.039072	0.04884	0.042979	0.00535
Average resilient def. (mm)	0.202698	0.202698	0.20757	0.202698	0.207595	0.204652	0.002675
Axial 1 resilient def. (mm)	0.198242	0.198242	0.203077	0.198242	0.200659	0.199692	0.002162
Axial 2 resilient def. (mm)	0.207155	0.207155	0.212063	0.207155	0.21453	0.209612	0.003475
Actuator resilient def. (mm)	0.322344	0.32967	0.32967	0.32967	0.32967	0.328205	0.003276
Average permanent def. (mm)	0.936081	0.936081	0.933639	0.936081	0.932405	0.934857	0.001731
Axial 1 permanent def. (mm)	0.936215	0.936215	0.933797	0.936215	0.933797	0.935248	0.001324
Axial 2 permanent def. (mm)	0.935946	0.935946	0.93348	0.935946	0.931013	0.934466	0.002206
Actuator permanent def. (mm)	0.974359	0.967033	0.967033	0.967033	0.967033	0.968498	0.003276
Sequence Number	61						
Cycle Number	196	197	198	199	200	Average	Std Dev.
Resilient Modulus (MPa)	420.685841	421.70063	420.685841	422.67229	420.685841	421.286088	0.890827
Resilient micro-strain	1286.019536	1279.97558	1286.019536	1279.97558	1286.019536	1283.601954	3.310411
Confining pressure (kPa)	30.47619	30.47619	30.18315	30.47619	30.47619	30.417582	0.131052
Maximum axial stress (kPa)	548.472419	547.228718	548.472419	548.472419	548.472419	548.223679	0.5562
Cyclic stress (kPa)	541.010209	539.766508	541.010209	541.010209	541.010209	540.761469	0.5562
Contact stress (kPa)	7.46221	7.46221	7.46221	7.46221	7.46221	7.46221	0
Permanent strain (%)	0.485134	0.485134	0.485134	0.485739	0.485134	0.485255	0.00027
Maximum load (kN)	4.307692	4.297924	4.307692	4.307692	4.307692	4.305739	0.004368
Cyclic load (kN)	4.249084	4.239316	4.249084	4.249084	4.249084	4.247131	0.004368
Contact load (kN)	0.058608	0.058608	0.058608	0.058608	0.058608	0.058608	0
Average resilient def. (mm)	0.257204	0.255995	0.257204	0.255995	0.257204	0.25672	0.000662
Axial 1 resilient def. (mm)	0.251429	0.249011	0.251429	0.249011	0.251429	0.250462	0.001324
Axial 2 resilient def. (mm)	0.262979	0.262979	0.262979	0.262979	0.262979	0.262979	0
Actuator resilient def. (mm)	0.43956	0.43956	0.432234	0.432234	0.432234	0.435165	0.004013
Average permanent def. (mm)	0.970269	0.970269	0.970269	0.971477	0.970269	0.97051	0.000541
Axial 1 permanent def. (mm)	0.970061	0.970061	0.970061	0.972479	0.970061	0.970545	0.001081
Axial 2 permanent def. (mm)	0.970476	0.970476	0.970476	0.970476	0.970476	0.970476	0
Actuator permanent def. (mm)	0.996337	0.996337	0.996337	1.003663	0.996337	0.997802	0.003276
Sequence Number	62						
Cycle Number	196	197	198	199	200	Average	Std Dev.
Resilient Modulus (MPa)	344.048352	340.198725	345.226395	341.363369	340.970454	342.361459	2.159975
Resilient micro-strain	1073.626374	1085.775336	1073.565324	1085.714286	1079.67033	1079.67033	6.074558
Confining pressure (kPa)	20.21978	20.512821	20.21978	20.21978	20.21978	20.278388	0.131052
Maximum axial stress (kPa)	374.354191	374.354191	375.597893	376.841594	374.354191	375.100412	1.112401
Cyclic stress (kPa)	369.379384	369.379384	370.623086	370.623086	368.135683	369.628125	1.040555
Contact stress (kPa)	4.974807	4.974807	4.974807	6.218508	6.218508	5.472287	0.681203
Permanent strain (%)	0.48025	0.48025	0.481471	0.481471	0.479646	0.480618	0.000817
Maximum load (kN)	2.940171	2.940171	2.949939	2.959707	2.940171	2.946032	0.008737
Cyclic load (kN)	2.901099	2.901099	2.910867	2.910867	2.891331	2.903053	0.008173
Contact load (kN)	0.039072	0.039072	0.039072	0.04884	0.04884	0.042979	0.00535
Average resilient def. (mm)	0.214725	0.217155	0.214713	0.217143	0.215934	0.215934	0.001215
Axial 1 resilient def. (mm)	0.21033	0.212747	0.21033	0.212747	0.212747	0.21178	0.001324
Axial 2 resilient def. (mm)	0.219121	0.221563	0.219096	0.221538	0.219121	0.220088	0.001335
Actuator resilient def. (mm)	0.336996	0.344322	0.344322	0.351648	0.351648	0.345788	0.006129
Average permanent def. (mm)	0.960501	0.960501	0.962943	0.962943	0.959292	0.961236	0.001635
Axial 1 permanent def. (mm)	0.960391	0.960391	0.962808	0.962808	0.957973	0.960874	0.002023
Axial 2 permanent def. (mm)	0.960611	0.960611	0.963077	0.963077	0.960611	0.961597	0.001351
Actuator permanent def. (mm)	0.996337	0.996337	0.996337	0.996337	0.989011	0.994872	0.003276
Sequence Number	63						
Cycle Number	196	197	198	199	200	Average	Std Dev.
Resilient Modulus (MPa)	420.485569	424.31604	419.525616	420.485569	416.704904	420.30354	2.725884
Resilient micro-strain	1345.787546	1333.638584	1351.831502	1345.787546	1357.997558	1347.008547	9.024368
Confining pressure (kPa)	30.47619	30.47619	30.769231	30.47619	30.47619	30.534799	0.131052
Maximum axial stress (kPa)	573.346452	573.346452	574.590154	573.346452	573.346452	573.595192	0.5562
Cyclic stress (kPa)	565.884242	565.884242	567.127944	565.884242	565.884242	566.132982	0.5562
Contact stress (kPa)	7.46221	7.46221	7.46221	7.46221	7.46221	7.46221	0
Permanent strain (%)	0.50467	0.50467	0.50467	0.50467	0.503449	0.504426	0.000546
Maximum load (kN)	4.503053	4.503053	4.512821	4.503053	4.503053	4.505006	0.004368
Cyclic load (kN)	4.444444	4.444444	4.454212	4.444444	4.444444	4.446398	0.004368
Contact load (kN)	0.058608	0.058608	0.058608	0.058608	0.058608	0.058608	0
Average resilient def. (mm)	0.269158	0.266728	0.270366	0.269158	0.2716	0.269402	0.001805
Axial 1 resilient def. (mm)	0.263516	0.261099	0.265934	0.263516	0.265934	0.264	0.002023
Axial 2 resilient def. (mm)	0.274799	0.272357	0.274799	0.274799	0.277265	0.274803	0.001735

Actuator resilient def. (mm)	0.454212	0.446886	0.461538	0.454212	0.454212	0.454212	0.00518
Average permanent def. (mm)	1.009341	1.009341	1.009341	1.009341	1.006899	1.008852	0.001092
Axial 1 permanent def. (mm)	1.008742	1.008742	1.008742	1.008742	1.006325	1.008259	0.001081
Axial 2 permanent def. (mm)	1.009939	1.009939	1.009939	1.009939	1.007473	1.009446	0.001103
Actuator permanent def. (mm)	1.047619	1.047619	1.040293	1.040293	1.040293	1.043223	0.004013
Sequence Number	64						
Cycle Number	196	197	198	199	200	Average	Std Dev.
Resilient Modulus (MPa)	349.735769	347.870662	349.735769	349.735769	345.988265	348.613247	1.674972
Resilient micro-strain	1127.289377	1133.333333	1127.289377	1127.289377	1139.499389	1130.940171	5.453722
Confining pressure (kPa)	20.21978	20.21978	20.21978	20.21978	20.512821	20.278388	0.131052
Maximum axial stress (kPa)	399.228224	400.471925	399.228224	399.228224	399.228224	399.476964	0.5562
Cyclic stress (kPa)	394.253417	394.253417	394.253417	394.253417	394.253417	394.253417	0
Contact stress (kPa)	4.974807	6.218508	4.974807	4.974807	4.974807	5.223547	0.5562
Permanent strain (%)	0.501007	0.501007	0.501007	0.501007	0.500391	0.500884	0.000276
Maximum load (kN)	3.135531	3.145299	3.135531	3.135531	3.135531	3.137485	0.004368
Cyclic load (kN)	3.096459	3.096459	3.096459	3.096459	3.096459	3.096459	0
Contact load (kN)	0.039072	0.04884	0.039072	0.039072	0.039072	0.041026	0.004368
Average resilient def. (mm)	0.225458	0.226667	0.225458	0.225458	0.2279	0.226188	0.001091
Axial 1 resilient def. (mm)	0.22	0.222418	0.22	0.22	0.222418	0.220967	0.001324
Axial 2 resilient def. (mm)	0.230916	0.230916	0.230916	0.230916	0.233382	0.231409	0.001103
Actuator resilient def. (mm)	0.358974	0.3663	0.358974	0.358974	0.3663	0.361905	0.004013
Average permanent def. (mm)	1.002015	1.002015	1.002015	1.002015	1.000781	1.001768	0.000552
Axial 1 permanent def. (mm)	1.00149	1.00149	1.00149	1.00149	1.00149	1.00149	0
Axial 2 permanent def. (mm)	1.00254	1.00254	1.00254	1.00254	1.000073	1.002046	0.001103
Actuator permanent def. (mm)	1.032967	1.032967	1.032967	1.032967	1.032967	1.032967	0
Sequence Number	65						
Cycle Number	196	197	198	199	200	Average	Std Dev.
Resilient Modulus (MPa)	397.396115	393.50941	392.604913	394.505636	392.604913	394.124197	1.990311
Resilient micro-strain	1236.202686	1248.412698	1254.456654	1248.412698	1254.456654	1248.388278	7.452185
Confining pressure (kPa)	19.92674	20.512821	20.21978	20.21978	20.512821	20.278388	0.245175
Maximum axial stress (kPa)	498.724354	497.480652	498.724354	498.724354	498.724354	498.475614	0.5562
Cyclic stress (kPa)	491.262144	491.262144	492.505846	492.505846	492.505846	492.008365	0.681203
Contact stress (kPa)	7.46221	6.218508	6.218508	6.218508	6.218508	6.467248	0.5562
Permanent strain (%)	0.509554	0.508333	0.508333	0.508333	0.508333	0.508578	0.000546
Maximum load (kN)	3.916972	3.907204	3.916972	3.916972	3.916972	3.915018	0.004368
Cyclic load (kN)	3.858364	3.858364	3.868132	3.868132	3.868132	3.864225	0.00535
Contact load (kN)	0.058608	0.04884	0.04884	0.04884	0.04884	0.050794	0.004368
Average resilient def. (mm)	0.247241	0.249683	0.250891	0.249683	0.250891	0.249678	0.00149
Axial 1 resilient def. (mm)	0.241758	0.244176	0.246593	0.244176	0.246593	0.244659	0.002023
Axial 2 resilient def. (mm)	0.252723	0.255189	0.255189	0.255189	0.255189	0.254696	0.001103
Actuator resilient def. (mm)	0.410256	0.410256	0.410256	0.410256	0.410256	0.410256	0
Average permanent def. (mm)	1.019109	1.016667	1.016667	1.016667	1.016667	1.017155	0.001092
Axial 1 permanent def. (mm)	1.018413	1.015995	1.015995	1.015995	1.015995	1.016479	0.001081
Axial 2 permanent def. (mm)	1.019805	1.017338	1.017338	1.017338	1.017338	1.017832	0.001103
Actuator permanent def. (mm)	1.047619	1.047619	1.047619	1.047619	1.047619	1.047619	0

Appendix C: Red Sand Stabilisation

HCTCRB

IPC Global Universal Testing Machine							
UTM_41 V2.03b Resilient Modulus Test							
Filename		D:\my research\Lab test Data\Resilient Modulus\Resilient modulus\					
Operator		Peerapong Jitsangiam					
Test method		Non Standard Testing					
Notes/Comments		ths test follows the standard of Ausroads (APRG 00/33(MA))					
Specimen Information							
********************							
Identification	CR2GPC						
Core/Sample Number	1						
Dimensions	Point 1	Point 2	Point 3	Point 4	Point 5	Average	Std Dev.
Diameter (mm)	100					100	
Height (mm)	195					195	
Cross-Sectional area	7853.982						
Volume	1531526						
Comments/Properties							
Setup Parameters							
****************							
Dynamic loading options							
Wave shape	Square pulse						
Load duration (msec)	1000						
Cycle duration (msec)	3000						
Contact stress [% of max. stress]	1						
Conditioning Cycles	1000						
Cycles per test sequence	200						
Shear test options							
Confining pressure (kPa)	34.5						
Strain rate (%/min)	1						
Gauge length (mm)	195						
Test termination strain (%)							
Sequence #	Confining Pressure (kPa)	Maximum Stress (kPa)					
0	50	100					
1	75	150					
2	100	200					
3	125	250					
4	150	300					
5	100	200					
6	50	150					
7	75	225					
8	100	300					
9	125	375					
10	150	450					
11	75	225					
12	40	125					
13	30	100					
14	40	150					
15	50	200					
16	75	300					
17	100	400					
18	125	500					
19	75	300					
20	30	125					
21	20	100					
22	30	150					
23	40	200					
24	50	250					
25	75	375					
26	100	500					
27	50	250					
28	30	180					
29	50	300					
30	75	450					
31	50	300					
32	30	180					
33	40	250					
34	30	210					
35	40	280					

36	50	350
37	75	525
38	40	280
39	20	150
40	30	245
41	40	325
42	50	400
43	30	245
44	20	185
45	30	275
46	40	370
47	50	450
48	30	275
49	20	225
50	30	335
51	40	450
52	50	550
53	20	250
54	30	375
55	40	500
56	20	300
57	30	450
58	40	600
59	30	500
60	20	350
61	30	550
62	20	375
63	30	575
64	20	400
65	20	500

Calibration Information
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Channel description	Filename	Transducer description	Span	Units	Date	Linearised
A: Axial Force	Y12346.CAR	STC5000 S/N: Y12346 +/-20kN	40	kN	7/12/2005	No
B: Actuator LVDT	941C-340.CAR	AC-15 S/N: M992941C-340 +/-15mm	30	mm	7/12/2005	No
C: Axial LVDT #1	83047.car	D6-05000A S/N: 83047 +/-5mm	10	mm	20/12/2005	Yes
D: Axial LVDT #2	83048.car	D6-05000A S/N: 83048 +/-5mm	10	mm	20/12/2005	Yes
E: Confining Pressure	S054042.CAR	Pressure S/N: S054042 +/-600kPa	1200	kPa	22/02/2006	No

Test Results
****

Start date and time Tuesday January 30 2007 at 9:35 AM

Sequence Number	0						
Cycle Number	996	997	998	999	1000	Average	Std Dev.
Resilient Modulus (MPa)	236.387529	240.003123	247.615656	240.645834	240.003123	240.931053	4.096675
Resilient micro-strain	415.641339	409.379794	396.794089	403.118249	409.379794	406.862653	7.161247
Confining pressure (kPa)	50.10989	50.40293	50.40293	50.695971	50.40293	50.40293	0.207211
Maximum axial stress (kPa)	100.739832	100.739832	100.739832	100.739832	100.739832	100.739832	0
Cyclic stress (kPa)	98.252429	98.252429	98.252429	97.008727	98.252429	98.003689	0.5562
Contact stress (kPa)	2.487403	2.487403	2.487403	3.731105	2.487403	2.736144	0.5562
Permanent strain (%)	0.140709	0.141968	0.141968	0.141968	0.140709	0.141465	0.000689
Maximum load (kN)	0.791209	0.791209	0.791209	0.791209	0.791209	0.791209	0
Cyclic load (kN)	0.771673	0.771673	0.771673	0.761905	0.771673	0.769719	0.004368
Contact load (kN)	0.019536	0.019536	0.019536	0.029304	0.019536	0.02149	0.004368
Average resilient def. (mm)	0.08105	0.079829	0.077375	0.078608	0.079829	0.079338	0.001396
Axial 1 resilient def. (mm)	0.068376	0.065934	0.063492	0.063492	0.065934	0.065446	0.002043
Axial 2 resilient def. (mm)	0.093724	0.093724	0.091258	0.093724	0.093724	0.093231	0.001103
Actuator resilient def. (mm)	0.139194	0.139194	0.14652	0.14652	0.139194	0.142125	0.004013
Average permanent def. (mm)	0.274383	0.276838	0.276838	0.276838	0.274383	0.275856	0.001344
Axial 1 permanent def. (mm)	0.270061	0.272503	0.272503	0.272503	0.270061	0.271526	0.001338
Axial 2 permanent def. (mm)	0.278706	0.281172	0.281172	0.281172	0.278706	0.280186	0.001351
Actuator permanent def. (mm)	0.285714	0.285714	0.285714	0.285714	0.285714	0.285714	0

Sequence Number	1						
Cycle Number	196	197	198	199	200	Average	Std Dev.
Resilient Modulus (MPa)	290.071702	297.509438	285.39506	292.529937	288.918456	290.884919	4.507138
Resilient micro-strain	505.932814	493.284493	518.581134	505.932814	512.256974	507.197646	9.380245
Confining pressure (kPa)	75.604396	75.311355	75.604396	75.604396	75.311355	75.487179	0.160505
Maximum axial stress (kPa)	150.487897	150.487897	150.487897	150.487897	150.487897	150.487897	0
Cyclic stress (kPa)	146.756792	146.756792	148.000494	148.000494	148.000494	147.503013	0.681203
Contact stress (kPa)	3.731105	3.731105	2.487403	2.487403	2.487403	2.984884	0.681203
Permanent strain (%)	0.249178	0.249178	0.247913	0.249178	0.248546	0.248799	0.000566
Maximum load (kN)	1.181929	1.181929	1.181929	1.181929	1.181929	1.181929	0
Cyclic load (kN)	1.152625	1.152625	1.162393	1.162393	1.162393	1.158486	0.00535
Contact load (kN)	0.029304	0.029304	0.019536	0.019536	0.019536	0.023443	0.00535
Average resilient def. (mm)	0.098657	0.09619	0.101123	0.098657	0.09989	0.098904	0.001829

Axial 1 resilient def. (mm)	0.083858	0.081392	0.086325	0.083858	0.083858	0.083858	0.001744
Axial 2 resilient def. (mm)	0.113455	0.110989	0.115922	0.113455	0.115922	0.113949	0.002064
Actuator resilient def. (mm)	0.18315	0.175824	0.18315	0.18315	0.18315	0.181685	0.003276
Average permanent def. (mm)	0.485897	0.485897	0.483431	0.485897	0.484664	0.485158	0.001103
Axial 1 permanent def. (mm)	0.480977	0.480977	0.47851	0.480977	0.480977	0.480484	0.001103
Axial 2 permanent def. (mm)	0.490818	0.490818	0.488352	0.490818	0.488352	0.489832	0.001351
Actuator permanent def. (mm)	0.483516	0.483516	0.483516	0.483516	0.483516	0.483516	0
Sequence Number	2						
Cycle Number	196	197	198	199	200	Average	Std Dev.
Resilient Modulus (MPa)	345.587582	343.362507	345.587582	341.786194	347.736552	344.812083	2.291975
Resilient micro-strain	568.610876	568.673492	568.610876	574.935036	568.673492	569.900755	2.814423
Confining pressure (kPa)	100.21978	100.512821	100.21978	100.512821	100.512821	100.395604	0.160505
Maximum axial stress (kPa)	200.235963	200.235963	200.235963	200.235963	201.479664	200.484703	0.5562
Cyclic stress (kPa)	196.504858	195.261156	196.504858	196.504858	197.748559	196.504858	0.87943
Contact stress (kPa)	3.731105	4.974807	3.731105	3.731105	3.731105	3.979845	0.5562
Permanent strain (%)	0.28902	0.288388	0.28902	0.288388	0.288388	0.288641	0.000346
Maximum load (kN)	1.57265	1.57265	1.57265	1.57265	1.582418	1.574603	0.004368
Cyclic load (kN)	1.543346	1.533578	1.543346	1.543346	1.553114	1.543346	0.006907
Contact load (kN)	0.029304	0.039072	0.029304	0.029304	0.029304	0.031258	0.004368
Average resilient def. (mm)	0.110879	0.110891	0.110879	0.112112	0.110891	0.111131	0.000549
Axial 1 resilient def. (mm)	0.095971	0.093529	0.095971	0.095971	0.093529	0.094994	0.001338
Axial 2 resilient def. (mm)	0.125788	0.128254	0.125788	0.128254	0.128254	0.127267	0.001351
Actuator resilient def. (mm)	0.205128	0.205128	0.205128	0.212454	0.212454	0.208059	0.004013
Average permanent def. (mm)	0.56359	0.562357	0.56359	0.562357	0.562357	0.56285	0.000675
Axial 1 permanent def. (mm)	0.562369	0.562369	0.562369	0.562369	0.562369	0.562369	0
Axial 2 permanent def. (mm)	0.564811	0.562344	0.564811	0.562344	0.562344	0.563331	0.001351
Actuator permanent def. (mm)	0.556777	0.549451	0.556777	0.549451	0.549451	0.552381	0.004013
Sequence Number	3						
Cycle Number	196	197	198	199	200	Average	Std Dev.
Resilient Modulus (MPa)	385.167809	389.116444	385.205726	385.167809	385.167809	385.965119	1.761721
Resilient micro-strain	636.110328	636.047713	636.047713	636.110328	636.110328	636.085282	0.034296
Confining pressure (kPa)	125.421245	125.421245	125.421245	125.714286	125.421245	125.479853	0.131052
Maximum axial stress (kPa)	249.984028	251.227729	249.984028	249.984028	249.984028	250.232768	0.5562
Cyclic stress (kPa)	245.009221	247.496625	245.009221	245.009221	245.009221	245.506702	1.112401
Contact stress (kPa)	4.974807	3.731105	4.974807	4.974807	4.974807	4.726066	0.5562
Permanent strain (%)	0.322538	0.323803	0.323171	0.322538	0.322538	0.322918	0.000566
Maximum load (kN)	1.96337	1.973138	1.96337	1.96337	1.96337	1.965324	0.004368
Cyclic load (kN)	1.924298	1.943834	1.924298	1.924298	1.924298	1.928205	0.008737
Contact load (kN)	0.039072	0.029304	0.039072	0.039072	0.039072	0.037118	0.004368
Average resilient def. (mm)	0.124042	0.124029	0.124029	0.124042	0.124042	0.124037	0.000007
Axial 1 resilient def. (mm)	0.107497	0.107473	0.107473	0.107497	0.107497	0.107487	0.000013
Axial 2 resilient def. (mm)	0.140586	0.140586	0.140586	0.140586	0.140586	0.140586	0
Actuator resilient def. (mm)	0.241758	0.241758	0.234432	0.241758	0.234432	0.238828	0.004013
Average permanent def. (mm)	0.62895	0.631416	0.630183	0.62895	0.62895	0.62969	0.001103
Axial 1 permanent def. (mm)	0.631429	0.633895	0.633895	0.631429	0.631429	0.632415	0.001351
Axial 2 permanent def. (mm)	0.626471	0.628938	0.626471	0.626471	0.626471	0.626965	0.001103
Actuator permanent def. (mm)	0.615385	0.622711	0.622711	0.615385	0.615385	0.618315	0.004013
Sequence Number	4						
Cycle Number	196	197	198	199	200	Average	Std Dev.
Resilient Modulus (MPa)	425.548838	421.481516	429.139967	431.282162	427.344403	426.959377	3.72781
Resilient micro-strain	692.652077	705.237782	692.652077	686.327917	692.652077	693.904386	6.902057
Confining pressure (kPa)	150.32967	150.622711	150.32967	150.32967	150.622711	150.446886	0.160505
Maximum axial stress (kPa)	299.732093	302.219496	302.219496	300.975795	300.975795	301.224535	1.040555
Cyclic stress (kPa)	294.757287	297.24469	297.24469	296.000988	296.000988	296.249729	1.040555
Contact stress (kPa)	4.974807	4.974807	4.974807	4.974807	4.974807	4.974807	0
Permanent strain (%)	0.352124	0.352124	0.352124	0.352124	0.352124	0.352124	0
Maximum load (kN)	2.35409	2.373626	2.373626	2.363858	2.363858	2.365812	0.008173
Cyclic load (kN)	2.315018	2.334554	2.334554	2.324786	2.324786	2.32674	0.008173
Contact load (kN)	0.039072	0.039072	0.039072	0.039072	0.039072	0.039072	0
Average resilient def. (mm)	0.135067	0.137521	0.135067	0.133834	0.135067	0.135311	0.001346
Axial 1 resilient def. (mm)	0.117216	0.119658	0.117216	0.117216	0.117216	0.117705	0.001092
Axial 2 resilient def. (mm)	0.152918	0.155385	0.152918	0.150452	0.152918	0.152918	0.001744
Actuator resilient def. (mm)	0.25641	0.271062	0.271062	0.263736	0.271062	0.266667	0.006553
Average permanent def. (mm)	0.686642	0.686642	0.686642	0.686642	0.686642	0.686642	0
Axial 1 permanent def. (mm)	0.690085	0.690085	0.690085	0.690085	0.690085	0.690085	0
Axial 2 permanent def. (mm)	0.683199	0.683199	0.683199	0.683199	0.683199	0.683199	0
Actuator permanent def. (mm)	0.666667	0.659341	0.666667	0.659341	0.659341	0.662271	0.004013
Sequence Number	5						
Cycle Number	196	197	198	199	200	Average	Std Dev.
Resilient Modulus (MPa)	334.124351	328.512596	331.987817	331.987817	330.59179	331.440874	2.067311
Resilient micro-strain	591.841207	598.165367	591.903823	591.903823	598.165367	594.395917	3.441116
Confining pressure (kPa)	100.21978	100.512821	100.512821	100.512821	100.512821	100.454212	0.131052
Maximum axial stress (kPa)	201.479664	200.235963	200.235963	200.235963	201.479664	200.733443	0.681203
Cyclic stress (kPa)	197.748559	196.504858	196.504858	196.504858	197.748559	197.002338	0.681203

Contact stress (kPa)	3.731105	3.731105	3.731105	3.731105	3.731105	3.731105	0
Permanent strain (%)	0.330729	0.330096	0.331355	0.331355	0.330096	0.330726	0.000629
Maximum load (kN)	1.582418	1.57265	1.57265	1.57265	1.582418	1.576557	0.00535
Cyclic load (kN)	1.553114	1.543346	1.543346	1.543346	1.553114	1.547253	0.00535
Contact load (kN)	0.029304	0.029304	0.029304	0.029304	0.029304	0.029304	0
Average resilient def. (mm)	0.115409	0.116642	0.115421	0.115421	0.116642	0.115907	0.000671
Axial 1 resilient def. (mm)	0.102564	0.102564	0.100122	0.100122	0.102564	0.101587	0.001338
Axial 2 resilient def. (mm)	0.128254	0.13072	0.13072	0.13072	0.13072	0.130227	0.001103
Actuator resilient def. (mm)	0.21978	0.21978	0.212454	0.212454	0.212454	0.215385	0.004013
Average permanent def. (mm)	0.644921	0.643687	0.646142	0.646142	0.643687	0.644916	0.001227
Axial 1 permanent def. (mm)	0.648571	0.648571	0.651013	0.651013	0.648571	0.649548	0.001338
Axial 2 permanent def. (mm)	0.64127	0.638803	0.64127	0.64127	0.638803	0.640283	0.001351
Actuator permanent def. (mm)	0.630037	0.630037	0.637363	0.637363	0.637363	0.634432	0.004013
Sequence Number	6						
Cycle Number	196	197	198	199	200	Average	Std Dev.
Resilient Modulus (MPa)	237.051639	239.477395	235.059608	237.051639	236.646587	237.057374	1.582433
Resilient micro-strain	624.338624	618.014464	624.338624	624.338624	630.662785	624.338624	4.471857
Confining pressure (kPa)	50.695971	50.989011	50.40293	50.40293	50.40293	50.578755	0.262103
Maximum axial stress (kPa)	150.487897	150.487897	150.487897	150.487897	151.731599	150.736638	0.5562
Cyclic stress (kPa)	148.000494	148.000494	146.756792	148.000494	149.244196	148.000494	0.87943
Contact stress (kPa)	2.487403	2.487403	3.731105	2.487403	2.487403	2.736144	0.5562
Permanent strain (%)	0.302934	0.303566	0.302934	0.302301	0.302301	0.302807	0.000529
Maximum load (kN)	1.181929	1.181929	1.181929	1.181929	1.191697	1.183883	0.004368
Cyclic load (kN)	1.162393	1.162393	1.152625	1.162393	1.172161	1.162393	0.006907
Contact load (kN)	0.019536	0.019536	0.029304	0.019536	0.019536	0.02149	0.004368
Average resilient def. (mm)	0.121746	0.120513	0.121746	0.121746	0.122979	0.121746	0.000872
Axial 1 resilient def. (mm)	0.110305	0.107839	0.110305	0.110305	0.110305	0.109812	0.001103
Axial 2 resilient def. (mm)	0.133187	0.133187	0.133187	0.133187	0.135653	0.13368	0.001103
Actuator resilient def. (mm)	0.205128	0.197802	0.205128	0.205128	0.205128	0.203663	0.003276
Average permanent def. (mm)	0.59072	0.591954	0.59072	0.589487	0.589487	0.590474	0.001032
Axial 1 permanent def. (mm)	0.594432	0.596899	0.594432	0.594432	0.594432	0.594926	0.001103
Axial 2 permanent def. (mm)	0.587009	0.587009	0.587009	0.584542	0.584542	0.586022	0.001351
Actuator permanent def. (mm)	0.600733	0.608059	0.600733	0.600733	0.600733	0.602198	0.003276
Sequence Number	7						
Cycle Number	196	197	198	199	200	Average	Std Dev.
Resilient Modulus (MPa)	305.709604	303.088861	302.17526	313.934609	308.402963	306.662259	4.736217
Resilient micro-strain	724.147647	730.409192	736.733352	705.175167	717.823487	722.857769	12.137113
Confining pressure (kPa)	75.604396	75.604396	75.897436	75.311355	75.018315	75.487179	0.334117
Maximum axial stress (kPa)	225.109995	225.109995	226.353697	225.109995	225.109995	225.358736	0.5562
Cyclic stress (kPa)	221.37889	221.37889	222.622592	221.37889	221.37889	221.627631	0.5562
Contact stress (kPa)	3.731105	3.731105	3.731105	3.731105	3.731105	3.731105	0
Permanent strain (%)	0.322538	0.322538	0.321906	0.323803	0.322538	0.322665	0.000693
Maximum load (kN)	1.76801	1.76801	1.777778	1.76801	1.76801	1.769963	0.004368
Cyclic load (kN)	1.738706	1.738706	1.748474	1.738706	1.738706	1.740659	0.004368
Contact load (kN)	0.029304	0.029304	0.029304	0.029304	0.029304	0.029304	0
Average resilient def. (mm)	0.141209	0.14243	0.143663	0.137509	0.139976	0.140957	0.002367
Axial 1 resilient def. (mm)	0.124567	0.127009	0.129475	0.1221	0.124567	0.125543	0.0028
Axial 2 resilient def. (mm)	0.157851	0.157851	0.157851	0.152918	0.155385	0.156371	0.002206
Actuator resilient def. (mm)	0.249084	0.249084	0.249084	0.249084	0.249084	0.249084	0
Average permanent def. (mm)	0.62895	0.62895	0.627717	0.631416	0.62895	0.629197	0.001351
Axial 1 permanent def. (mm)	0.633895	0.633895	0.631429	0.636361	0.633895	0.633895	0.001744
Axial 2 permanent def. (mm)	0.624005	0.624005	0.624005	0.626471	0.624005	0.624498	0.001103
Actuator permanent def. (mm)	0.630037	0.630037	0.630037	0.630037	0.630037	0.630037	0
Sequence Number	8						
Cycle Number	196	197	198	199	200	Average	Std Dev.
Resilient Modulus (MPa)	364.450218	371.742077	368.631264	368.631264	364.450218	367.581008	3.127469
Resilient micro-strain	812.184966	799.599261	799.599261	799.599261	812.184966	804.633543	6.893474
Confining pressure (kPa)	100.21978	100.21978	100.805861	100.512821	100.512821	100.454212	0.245175
Maximum axial stress (kPa)	300.975795	300.975795	299.732093	299.732093	300.975795	300.478314	0.681203
Cyclic stress (kPa)	296.000988	297.24469	294.757287	294.757287	296.000988	295.752248	1.040555
Contact stress (kPa)	4.974807	3.731105	4.974807	4.974807	4.974807	4.726066	0.5562
Permanent strain (%)	0.34394	0.345831	0.345831	0.345199	0.344573	0.345075	0.000821
Maximum load (kN)	2.363858	2.363858	2.35409	2.35409	2.363858	2.359951	0.00535
Cyclic load (kN)	2.324786	2.334554	2.315018	2.315018	2.324786	2.322833	0.008173
Contact load (kN)	0.039072	0.029304	0.039072	0.039072	0.039072	0.037118	0.004368
Average resilient def. (mm)	0.158376	0.155922	0.155922	0.155922	0.158376	0.156904	0.001344
Axial 1 resilient def. (mm)	0.141636	0.139194	0.139194	0.139194	0.141636	0.140171	0.001338
Axial 2 resilient def. (mm)	0.175116	0.17265	0.17265	0.17265	0.175116	0.173636	0.001351
Actuator resilient def. (mm)	0.29304	0.29304	0.278388	0.29304	0.29304	0.29011	0.006553
Average permanent def. (mm)	0.670684	0.674371	0.674371	0.673138	0.671917	0.672896	0.001602
Axial 1 permanent def. (mm)	0.675433	0.677875	0.677875	0.677875	0.675433	0.676899	0.001338
Axial 2 permanent def. (mm)	0.665934	0.670867	0.670867	0.6684	0.6684	0.668894	0.002064
Actuator permanent def. (mm)	0.659341	0.659341	0.666667	0.659341	0.659341	0.660806	0.003276
Sequence Number	9						

Cycle Number	196	197	198	199	200	Average	Std Dev.
Resilient Modulus (MPa)	410.291658	404.607233	417.509769	411.644481	414.70769	411.752166	4.875445
Resilient micro-strain	900.2849	912.933221	887.699195	900.347516	887.699195	897.792805	10.556173
Confining pressure (kPa)	125.421245	125.128205	125.128205	125.421245	125.421245	125.304029	0.160505
Maximum axial stress (kPa)	375.597893	375.597893	375.597893	376.841594	374.354191	375.597893	0.87943
Cyclic stress (kPa)	369.379384	369.379384	370.623086	370.623086	368.135683	369.628125	1.040555
Contact stress (kPa)	6.218508	6.218508	4.974807	6.218508	6.218508	5.969768	0.5562
Permanent strain (%)	0.375405	0.374772	0.376663	0.376663	0.376663	0.376033	0.000891
Maximum load (kN)	2.949939	2.949939	2.949939	2.959707	2.940171	2.949939	0.006907
Cyclic load (kN)	2.901099	2.901099	2.910867	2.910867	2.891331	2.903053	0.008173
Contact load (kN)	0.04884	0.04884	0.039072	0.04884	0.04884	0.046886	0.004368
Average resilient def. (mm)	0.175556	0.178022	0.173101	0.175568	0.173101	0.17507	0.002058
Axial 1 resilient def. (mm)	0.15873	0.15873	0.156288	0.156288	0.156288	0.157265	0.001338
Axial 2 resilient def. (mm)	0.192381	0.197314	0.189915	0.194847	0.189915	0.192874	0.003216
Actuator resilient def. (mm)	0.32967	0.32967	0.32967	0.336996	0.32967	0.331136	0.003276
Average permanent def. (mm)	0.732039	0.730806	0.734493	0.734493	0.734493	0.733265	0.001738
Axial 1 permanent def. (mm)	0.736484	0.736484	0.738926	0.738926	0.738926	0.737949	0.001338
Axial 2 permanent def. (mm)	0.727595	0.725128	0.730061	0.730061	0.730061	0.728581	0.002206
Actuator permanent def. (mm)	0.725275	0.725275	0.725275	0.725275	0.725275	0.725275	0
Sequence Number	10						
Cycle Number	196	197	198	199	200	Average	Std Dev.
Resilient Modulus (MPa)	452.965494	457.9518	457.9518	460.928606	460.928606	458.145261	3.25572
Resilient micro-strain	988.44745	969.537585	969.537585	963.27604	963.27604	970.81494	10.342131
Confining pressure (kPa)	150.03663	150.32967	150.915751	150.622711	150.32967	150.446886	0.334117
Maximum axial stress (kPa)	453.951095	450.21999	450.21999	450.21999	450.21999	450.966211	1.668601
Cyclic stress (kPa)	447.732587	444.001482	444.001482	444.001482	444.001482	444.747703	1.668601
Contact stress (kPa)	6.218508	6.218508	6.218508	6.218508	6.218508	6.218508	0
Permanent strain (%)	0.409386	0.410018	0.410018	0.410645	0.410645	0.410142	0.000526
Maximum load (kN)	3.565324	3.53602	3.53602	3.53602	3.53602	3.54188	0.013105
Cyclic load (kN)	3.516484	3.487179	3.487179	3.487179	3.487179	3.49304	0.013105
Contact load (kN)	0.04884	0.04884	0.04884	0.04884	0.04884	0.04884	0
Average resilient def. (mm)	0.192747	0.18906	0.18906	0.187839	0.187839	0.189309	0.002017
Axial 1 resilient def. (mm)	0.173382	0.17094	0.17094	0.168498	0.168498	0.170452	0.002043
Axial 2 resilient def. (mm)	0.212112	0.207179	0.207179	0.207179	0.207179	0.208166	0.002206
Actuator resilient def. (mm)	0.373626	0.3663	0.3663	0.358974	0.3663	0.3663	0.00518
Average permanent def. (mm)	0.798303	0.799536	0.799536	0.800757	0.800757	0.799778	0.001026
Axial 1 permanent def. (mm)	0.802418	0.802418	0.802418	0.80486	0.80486	0.803394	0.001338
Axial 2 permanent def. (mm)	0.794188	0.796654	0.796654	0.796654	0.796654	0.796161	0.001103
Actuator permanent def. (mm)	0.776557	0.776557	0.776557	0.783883	0.776557	0.778022	0.003276
Sequence Number	11						
Cycle Number	196	197	198	199	200	Average	Std Dev.
Resilient Modulus (MPa)	286.619031	292.240186	285.884335	289.857664	288.238347	288.567913	2.562099
Resilient micro-strain	768.041076	761.779531	774.365236	768.041076	768.041076	768.053599	4.449752
Confining pressure (kPa)	75.604396	75.604396	75.311355	75.604396	75.311355	75.487179	0.160505
Maximum axial stress (kPa)	225.109995	226.353697	225.109995	226.353697	225.109995	225.607476	0.681203
Cyclic stress (kPa)	220.135189	222.622592	221.37889	222.622592	221.37889	221.627631	1.040555
Contact stress (kPa)	4.974807	3.731105	3.731105	3.731105	3.731105	3.979845	0.5562
Permanent strain (%)	0.371629	0.371629	0.37037	0.371629	0.371629	0.371377	0.000563
Maximum load (kN)	1.76801	1.777778	1.76801	1.777778	1.76801	1.771917	0.00535
Cyclic load (kN)	1.728938	1.748474	1.738706	1.748474	1.738706	1.740659	0.008173
Contact load (kN)	0.039072	0.029304	0.029304	0.029304	0.029304	0.031258	0.004368
Average resilient def. (mm)	0.149768	0.148547	0.151001	0.149768	0.149768	0.14977	0.000868
Axial 1 resilient def. (mm)	0.136752	0.13431	0.136752	0.136752	0.136752	0.136264	0.001092
Axial 2 resilient def. (mm)	0.162784	0.162784	0.16525	0.162784	0.162784	0.163277	0.001103
Actuator resilient def. (mm)	0.25641	0.25641	0.25641	0.25641	0.25641	0.25641	0
Average permanent def. (mm)	0.724676	0.724676	0.722222	0.724676	0.724676	0.724186	0.001098
Axial 1 permanent def. (mm)	0.729158	0.729158	0.726716	0.729158	0.729158	0.728669	0.001092
Axial 2 permanent def. (mm)	0.720195	0.720195	0.717729	0.720195	0.720195	0.719702	0.001103
Actuator permanent def. (mm)	0.725275	0.725275	0.725275	0.725275	0.725275	0.725275	0
Sequence Number	12						
Cycle Number	196	197	198	199	200	Average	Std Dev.
Resilient Modulus (MPa)	197.556949	203.72888	195.582967	199.572836	203.655664	200.019459	3.637571
Resilient micro-strain	616.950002	604.364297	629.535706	616.950002	610.688457	615.697693	9.329597
Confining pressure (kPa)	40.43956	40.43956	40.14652	40.14652	40.14652	40.263736	0.160505
Maximum axial stress (kPa)	125.613865	125.613865	125.613865	125.613865	126.857566	125.862605	0.5562
Cyclic stress (kPa)	121.88276	123.126461	123.126461	123.126461	124.370163	123.126461	0.87943
Contact stress (kPa)	3.731105	2.487403	2.487403	2.487403	2.487403	2.736144	0.5562
Permanent strain (%)	0.345199	0.345199	0.34394	0.345199	0.345199	0.344947	0.000563
Maximum load (kN)	0.986569	0.986569	0.986569	0.986569	0.996337	0.988523	0.004368
Cyclic load (kN)	0.957265	0.967033	0.967033	0.967033	0.976801	0.967033	0.006907
Contact load (kN)	0.029304	0.019536	0.019536	0.019536	0.019536	0.02149	0.004368
Average resilient def. (mm)	0.120305	0.117851	0.122759	0.120305	0.119084	0.120061	0.001819
Axial 1 resilient def. (mm)	0.10989	0.107448	0.112332	0.10989	0.107448	0.109402	0.002043
Axial 2 resilient def. (mm)	0.13072	0.128254	0.133187	0.13072	0.13072	0.13072	0.001744
Actuator resilient def. (mm)	0.190476	0.190476	0.190476	0.190476	0.190476	0.190476	0

Average permanent def. (mm)	0.673138	0.673138	0.670684	0.673138	0.673138	0.672647	0.001098
Axial 1 permanent def. (mm)	0.677875	0.677875	0.675433	0.677875	0.677875	0.677387	0.001092
Axial 2 permanent def. (mm)	0.6684	0.6684	0.665934	0.6684	0.6684	0.667907	0.001103
Actuator permanent def. (mm)	0.695971	0.695971	0.695971	0.695971	0.695971	0.695971	0
Sequence Number	13						
Cycle Number	196	197	198	199	200	Average	Std Dev.
Resilient Modulus (MPa)	175.362138	179.391839	179.391839	177.364125	177.364125	177.774813	1.687296
Resilient micro-strain	560.283022	547.697317	547.697317	553.958862	553.958862	552.719076	5.261263
Confining pressure (kPa)	30.47619	30.47619	30.47619	30.769231	30.18315	30.47619	0.207211
Maximum axial stress (kPa)	100.739832	100.739832	100.739832	100.739832	100.739832	100.739832	0
Cyclic stress (kPa)	98.252429	98.252429	98.252429	98.252429	98.252429	98.252429	0
Contact stress (kPa)	2.487403	2.487403	2.487403	2.487403	2.487403	2.487403	0
Permanent strain (%)	0.337021	0.337648	0.337021	0.337021	0.337021	0.337147	0.00028
Maximum load (kN)	0.791209	0.791209	0.791209	0.791209	0.791209	0.791209	0
Cyclic load (kN)	0.771673	0.771673	0.771673	0.771673	0.771673	0.771673	0
Contact load (kN)	0.019536	0.019536	0.019536	0.019536	0.019536	0.019536	0
Average resilient def. (mm)	0.109255	0.106801	0.106801	0.108022	0.108022	0.10778	0.001026
Axial 1 resilient def. (mm)	0.100122	0.09768	0.09768	0.100122	0.100122	0.099145	0.001338
Axial 2 resilient def. (mm)	0.118388	0.115922	0.115922	0.115922	0.115922	0.116415	0.001103
Actuator resilient def. (mm)	0.175824	0.168498	0.161172	0.175824	0.168498	0.169963	0.006129
Average permanent def. (mm)	0.657192	0.658413	0.657192	0.657192	0.657192	0.657436	0.000546
Axial 1 permanent def. (mm)	0.660781	0.663223	0.660781	0.660781	0.660781	0.66127	0.001092
Axial 2 permanent def. (mm)	0.653602	0.653602	0.653602	0.653602	0.653602	0.653602	0
Actuator permanent def. (mm)	0.673993	0.681319	0.681319	0.673993	0.673993	0.676923	0.004013
Sequence Number	14						
Cycle Number	196	197	198	199	200	Average	Std Dev.
Resilient Modulus (MPa)	215.857373	211.678901	211.814848	213.730165	215.680435	213.752344	2.0126
Resilient micro-strain	679.878526	705.049936	698.725776	692.464231	686.202686	692.464231	9.939993
Confining pressure (kPa)	40.43956	40.43956	40.732601	40.14652	40.14652	40.380952	0.245175
Maximum axial stress (kPa)	150.487897	152.975301	151.731599	150.487897	150.487897	151.234118	1.112401
Cyclic stress (kPa)	146.756792	149.244196	148.000494	148.000494	148.000494	148.000494	0.87943
Contact stress (kPa)	3.731105	3.731105	3.731105	2.487403	2.487403	3.233624	0.681203
Permanent strain (%)	0.34709	0.34709	0.345831	0.345831	0.346458	0.34646	0.000629
Maximum load (kN)	1.181929	1.201465	1.191697	1.181929	1.181929	1.18779	0.008737
Cyclic load (kN)	1.152625	1.172161	1.162393	1.162393	1.162393	1.162393	0.006907
Contact load (kN)	0.029304	0.029304	0.029304	0.019536	0.019536	0.025397	0.00535
Average resilient def. (mm)	0.132576	0.137485	0.136252	0.135031	0.13381	0.135031	0.001938
Axial 1 resilient def. (mm)	0.1221	0.126984	0.126984	0.124542	0.1221	0.124542	0.002442
Axial 2 resilient def. (mm)	0.143053	0.147985	0.145519	0.145519	0.145519	0.145519	0.001744
Actuator resilient def. (mm)	0.21978	0.21978	0.21978	0.212454	0.212454	0.21685	0.004013
Average permanent def. (mm)	0.676825	0.676825	0.674371	0.674371	0.675592	0.675597	0.001227
Axial 1 permanent def. (mm)	0.680317	0.680317	0.677875	0.677875	0.680317	0.679341	0.001338
Axial 2 permanent def. (mm)	0.673333	0.673333	0.670867	0.670867	0.670867	0.671853	0.001351
Actuator permanent def. (mm)	0.688645	0.695971	0.688645	0.688645	0.688645	0.69011	0.003276
Sequence Number	15						
Cycle Number	196	197	198	199	200	Average	Std Dev.
Resilient Modulus (MPa)	249.723946	245.792672	251.747219	247.752493	245.046334	248.012533	2.76905
Resilient micro-strain	786.888325	799.47403	780.564165	793.14987	812.059735	794.427225	12.114317
Confining pressure (kPa)	50.989011	50.695971	50.40293	50.10989	50.10989	50.461538	0.382078
Maximum axial stress (kPa)	200.235963	200.235963	200.235963	200.235963	201.479664	200.484703	0.5562
Cyclic stress (kPa)	196.504858	196.504858	196.504858	196.504858	198.992261	197.002338	1.112401
Contact stress (kPa)	3.731105	3.731105	3.731105	3.731105	2.487403	3.482365	0.5562
Permanent strain (%)	0.357159	0.355268	0.357159	0.3559	0.3559	0.356277	0.000845
Maximum load (kN)	1.57265	1.57265	1.57265	1.57265	1.582418	1.574603	0.004368
Cyclic load (kN)	1.543346	1.543346	1.543346	1.543346	1.562882	1.547253	0.008737
Contact load (kN)	0.029304	0.029304	0.029304	0.029304	0.019536	0.02735	0.004368
Average resilient def. (mm)	0.153443	0.155897	0.15221	0.154664	0.158352	0.154913	0.002362
Axial 1 resilient def. (mm)	0.141636	0.144078	0.141636	0.144078	0.14652	0.14359	0.002043
Axial 2 resilient def. (mm)	0.16525	0.167717	0.162784	0.16525	0.170183	0.166237	0.002812
Actuator resilient def. (mm)	0.25641	0.249084	0.25641	0.25641	0.263736	0.25641	0.00518
Average permanent def. (mm)	0.696459	0.692772	0.696459	0.694005	0.694005	0.69474	0.001648
Axial 1 permanent def. (mm)	0.699853	0.697411	0.699853	0.697411	0.697411	0.698388	0.001338
Axial 2 permanent def. (mm)	0.693065	0.688132	0.693065	0.690598	0.690598	0.691092	0.002064
Actuator permanent def. (mm)	0.710623	0.710623	0.710623	0.710623	0.710623	0.710623	0
Sequence Number	16						
Cycle Number	196	197	198	199	200	Average	Std Dev.
Resilient Modulus (MPa)	330.190326	322.912693	322.912693	328.808777	328.808777	326.726653	3.527041
Resilient micro-strain	900.222285	912.80799	912.80799	900.222285	900.222285	905.256567	6.893474
Confining pressure (kPa)	75.311355	75.311355	75.311355	75.604396	75.018315	75.311355	0.207211
Maximum axial stress (kPa)	302.219496	299.732093	299.732093	299.732093	300.975795	300.478314	1.112401
Cyclic stress (kPa)	297.24469	294.757287	294.757287	296.000988	296.000988	295.752248	1.040555
Contact stress (kPa)	4.974807	4.974807	4.974807	3.731105	4.974807	4.726066	0.5562
Permanent strain (%)	0.379813	0.378554	0.378554	0.379813	0.379813	0.379309	0.000689
Maximum load (kN)	2.373626	2.35409	2.35409	2.35409	2.363858	2.359951	0.008737

Cyclic load (kN)	2.334554	2.315018	2.315018	2.324786	2.324786	2.322833	0.008173
Contact load (kN)	0.039072	0.039072	0.039072	0.029304	0.039072	0.037118	0.004368
Average resilient def. (mm)	0.175543	0.177998	0.177998	0.175543	0.175543	0.176525	0.001344
Axial 1 resilient def. (mm)	0.161172	0.163614	0.163614	0.161172	0.161172	0.162149	0.001338
Axial 2 resilient def. (mm)	0.189915	0.192381	0.192381	0.189915	0.189915	0.190901	0.001351
Actuator resilient def. (mm)	0.307692	0.315018	0.315018	0.307692	0.307692	0.310623	0.004013
Average permanent def. (mm)	0.740635	0.738181	0.738181	0.740635	0.740635	0.739653	0.001344
Axial 1 permanent def. (mm)	0.74381	0.741368	0.741368	0.74381	0.74381	0.742833	0.001338
Axial 2 permanent def. (mm)	0.73746	0.734994	0.734994	0.73746	0.73746	0.736474	0.001351
Actuator permanent def. (mm)	0.747253	0.739927	0.739927	0.747253	0.747253	0.744322	0.004013
Sequence Number	17						
Cycle Number	196	197	198	199	200	Average	Std Dev.
Resilient Modulus (MPa)	392.632979	391.422616	393.87115	396.35051	386.526171	392.160685	3.639913
Resilient micro-strain	1007.2947	1007.232084	1000.970539	994.708995	1013.556244	1004.752512	7.164012
Confining pressure (kPa)	100.805861	100.21978	100.512821	99.92674	100.512821	100.395604	0.334117
Maximum axial stress (kPa)	401.715627	400.471925	400.471925	399.228224	399.228224	400.223185	1.040555
Cyclic stress (kPa)	395.497119	394.253417	394.253417	394.253417	391.766014	394.004677	1.362407
Contact stress (kPa)	6.218508	6.218508	6.218508	4.974807	7.46221	6.218508	0.87943
Permanent strain (%)	0.402467	0.401208	0.401208	0.402467	0.401208	0.401712	0.000689
Maximum load (kN)	3.155067	3.145299	3.145299	3.135531	3.135531	3.143346	0.008173
Cyclic load (kN)	3.106227	3.096459	3.096459	3.096459	3.076923	3.094505	0.0107
Contact load (kN)	0.04884	0.04884	0.04884	0.039072	0.058608	0.04884	0.006907
Average resilient def. (mm)	0.196422	0.19641	0.195189	0.193968	0.197643	0.195927	0.001397
Axial 1 resilient def. (mm)	0.178266	0.180708	0.178266	0.175824	0.180708	0.178755	0.002043
Axial 2 resilient def. (mm)	0.214579	0.212112	0.212112	0.212112	0.214579	0.213099	0.001351
Actuator resilient def. (mm)	0.358974	0.351648	0.351648	0.351648	0.358974	0.354579	0.004013
Average permanent def. (mm)	0.784811	0.782357	0.782357	0.784811	0.782357	0.783338	0.001344
Axial 1 permanent def. (mm)	0.787766	0.785324	0.785324	0.787766	0.785324	0.7863	0.001338
Axial 2 permanent def. (mm)	0.781856	0.779389	0.779389	0.781856	0.779389	0.780376	0.001351
Actuator permanent def. (mm)	0.783883	0.783883	0.776557	0.783883	0.776557	0.780952	0.004013
Sequence Number	18						
Cycle Number	196	197	198	199	200	Average	Std Dev.
Resilient Modulus (MPa)	449.614989	444.507749	441.984975	441.735007	444.507749	444.470094	3.167384
Resilient micro-strain	1095.394634	1107.980339	1114.304499	1120.566044	1107.980339	1109.245171	9.33804
Confining pressure (kPa)	125.421245	125.421245	125.421245	125.714286	125.421245	125.479853	0.131052
Maximum axial stress (kPa)	499.968056	499.968056	499.968056	501.211757	499.968056	500.216796	0.5562
Cyclic stress (kPa)	492.505846	492.505846	492.505846	494.993249	492.505846	493.003327	1.112401
Contact stress (kPa)	7.46221	7.46221	7.46221	6.218508	7.46221	7.213469	0.5562
Permanent strain (%)	0.430156	0.429529	0.428897	0.430156	0.429529	0.429653	0.000526
Maximum load (kN)	3.92674	3.92674	3.92674	3.936508	3.92674	3.928694	0.004368
Cyclic load (kN)	3.868132	3.868132	3.868132	3.887668	3.868132	3.872039	0.008737
Contact load (kN)	0.058608	0.058608	0.058608	0.04884	0.058608	0.056654	0.004368
Average resilient def. (mm)	0.213602	0.216056	0.217289	0.21851	0.216056	0.216303	0.001821
Axial 1 resilient def. (mm)	0.19536	0.197802	0.197802	0.200244	0.197802	0.197802	0.001727
Axial 2 resilient def. (mm)	0.231844	0.23431	0.236777	0.236777	0.23431	0.234803	0.002064
Actuator resilient def. (mm)	0.395604	0.40293	0.410256	0.410256	0.410256	0.405861	0.006553
Average permanent def. (mm)	0.838803	0.837582	0.836349	0.838803	0.837582	0.837824	0.001026
Axial 1 permanent def. (mm)	0.84149	0.839048	0.839048	0.84149	0.839048	0.840024	0.001338
Axial 2 permanent def. (mm)	0.836117	0.836117	0.833651	0.836117	0.836117	0.835624	0.001103
Actuator permanent def. (mm)	0.835165	0.835165	0.827839	0.835165	0.827839	0.832234	0.004013
Sequence Number	19						
Cycle Number	196	197	198	199	200	Average	Std Dev.
Resilient Modulus (MPa)	315.573016	311.394755	311.394755	311.415269	310.086374	311.972834	2.091607
Resilient micro-strain	937.9794	950.565104	950.565104	950.502489	950.565104	948.03544	5.621563
Confining pressure (kPa)	75.604396	75.311355	75.311355	75.604396	75.311355	75.428571	0.160505
Maximum axial stress (kPa)	300.975795	300.975795	300.975795	300.975795	299.732093	300.727054	0.5562
Cyclic stress (kPa)	296.000988	296.000988	296.000988	296.000988	294.757287	295.752248	0.5562
Contact stress (kPa)	4.974807	4.974807	4.974807	4.974807	4.974807	4.974807	0
Permanent strain (%)	0.403726	0.402467	0.403726	0.403099	0.402467	0.403097	0.000629
Maximum load (kN)	2.363858	2.363858	2.363858	2.363858	2.35409	2.361905	0.004368
Cyclic load (kN)	2.324786	2.324786	2.324786	2.324786	2.315018	2.322833	0.004368
Contact load (kN)	0.039072	0.039072	0.039072	0.039072	0.039072	0.039072	0
Average resilient def. (mm)	0.182906	0.18536	0.18536	0.185348	0.18536	0.184867	0.001096
Axial 1 resilient def. (mm)	0.168498	0.17094	0.17094	0.173382	0.17094	0.17094	0.001727
Axial 2 resilient def. (mm)	0.197314	0.19978	0.19978	0.197314	0.19978	0.198794	0.001351
Actuator resilient def. (mm)	0.307692	0.315018	0.315018	0.315018	0.315018	0.313553	0.003276
Average permanent def. (mm)	0.787265	0.784811	0.787265	0.786044	0.784811	0.786039	0.001227
Axial 1 permanent def. (mm)	0.790208	0.787766	0.790208	0.787766	0.787766	0.788742	0.001338
Axial 2 permanent def. (mm)	0.784322	0.781856	0.784322	0.784322	0.781856	0.783336	0.001351
Actuator permanent def. (mm)	0.798535	0.791209	0.798535	0.791209	0.791209	0.794139	0.004013
Sequence Number	20						
Cycle Number	196	197	198	199	200	Average	Std Dev.
Resilient Modulus (MPa)	177.825208	182.801074	182.818069	181.117358	179.447997	180.801941	2.171111
Resilient micro-strain	692.401615	673.554366	673.49175	679.815911	686.140071	681.080743	8.209719

Confining pressure (kPa)	30.18315	30.47619	30.47619	30.47619	30.47619	30.417582	0.131052
Maximum axial stress (kPa)	126.857566	125.613865	125.613865	125.613865	125.613865	125.862605	0.5562
Cyclic stress (kPa)	123.126461	123.126461	123.126461	123.126461	123.126461	123.126461	0
Contact stress (kPa)	3.731105	2.487403	2.487403	2.487403	2.487403	2.736144	0.5562
Permanent strain (%)	0.366601	0.367227	0.367859	0.367859	0.367227	0.367355	0.000527
Maximum load (kN)	0.996337	0.986569	0.986569	0.986569	0.986569	0.988523	0.004368
Cyclic load (kN)	0.967033	0.967033	0.967033	0.967033	0.967033	0.967033	0
Contact load (kN)	0.029304	0.019536	0.019536	0.019536	0.019536	0.02149	0.004368
Average resilient def. (mm)	0.135018	0.131343	0.131331	0.132564	0.133797	0.132811	0.001601
Axial 1 resilient def. (mm)	0.126984	0.1221	0.124542	0.124542	0.124542	0.124542	0.001727
Axial 2 resilient def. (mm)	0.143053	0.140586	0.13812	0.140586	0.143053	0.141079	0.002064
Actuator resilient def. (mm)	0.212454	0.205128	0.197802	0.197802	0.197802	0.202198	0.006553
Average permanent def. (mm)	0.714872	0.716093	0.717326	0.717326	0.716093	0.716342	0.001027
Axial 1 permanent def. (mm)	0.716947	0.719389	0.719389	0.719389	0.719389	0.718901	0.001092
Axial 2 permanent def. (mm)	0.712796	0.712796	0.715263	0.715263	0.712796	0.713783	0.001351
Actuator permanent def. (mm)	0.732601	0.732601	0.739927	0.739927	0.739927	0.736996	0.004013
Sequence Number	21						
Cycle Number	196	197	198	199	200	Average	Std Dev.
Resilient Modulus (MPa)	159.271256	159.271256	157.670862	160.920974	158.883999	159.203669	1.162966
Resilient micro-strain	616.887386	616.887386	623.148931	610.563226	610.563226	615.610031	5.268747
Confining pressure (kPa)	20.21978	20.512821	20.21978	20.512821	20.512821	20.395604	0.160505
Maximum axial stress (kPa)	100.739832	100.739832	100.739832	100.739832	99.49613	100.491092	0.5562
Cyclic stress (kPa)	98.252429	98.252429	98.252429	98.252429	97.008727	98.003689	0.5562
Contact stress (kPa)	2.487403	2.487403	2.487403	2.487403	2.487403	2.487403	0
Permanent strain (%)	0.359049	0.359049	0.359049	0.359049	0.359049	0.359049	0
Maximum load (kN)	0.791209	0.791209	0.791209	0.791209	0.781441	0.789255	0.004368
Cyclic load (kN)	0.771673	0.771673	0.771673	0.771673	0.761905	0.769719	0.004368
Contact load (kN)	0.019536	0.019536	0.019536	0.019536	0.019536	0.019536	0
Average resilient def. (mm)	0.120293	0.120293	0.121514	0.11906	0.11906	0.120044	0.001027
Axial 1 resilient def. (mm)	0.112332	0.112332	0.114774	0.112332	0.112332	0.112821	0.001092
Axial 2 resilient def. (mm)	0.128254	0.128254	0.128254	0.125788	0.125788	0.127267	0.001351
Actuator resilient def. (mm)	0.190476	0.190476	0.18315	0.18315	0.18315	0.186081	0.004013
Average permanent def. (mm)	0.700147	0.700147	0.700147	0.700147	0.700147	0.700147	0
Axial 1 permanent def. (mm)	0.702295	0.702295	0.702295	0.702295	0.702295	0.702295	0
Axial 2 permanent def. (mm)	0.697998	0.697998	0.697998	0.697998	0.697998	0.697998	0
Actuator permanent def. (mm)	0.717949	0.717949	0.725275	0.725275	0.725275	0.722344	0.004013
Sequence Number	22						
Cycle Number	196	197	198	199	200	Average	Std Dev.
Resilient Modulus (MPa)	194.294898	194.294898	192.730095	192.714382	197.588032	194.324461	1.986643
Resilient micro-strain	755.33014	755.33014	767.915845	767.97846	755.33014	760.376945	6.910658
Confining pressure (kPa)	30.47619	30.47619	30.47619	30.47619	30.769231	30.534799	0.131052
Maximum axial stress (kPa)	150.487897	150.487897	150.487897	150.487897	151.731599	150.736638	0.5562
Cyclic stress (kPa)	146.756792	146.756792	148.000494	148.000494	149.244196	147.751754	1.040555
Contact stress (kPa)	3.731105	3.731105	2.487403	2.487403	2.487403	2.984884	0.681203
Permanent strain (%)	0.367859	0.369118	0.367859	0.368486	0.369118	0.368488	0.000629
Maximum load (kN)	1.181929	1.181929	1.181929	1.181929	1.191697	1.183883	0.004368
Cyclic load (kN)	1.152625	1.152625	1.162393	1.162393	1.172161	1.16044	0.008173
Contact load (kN)	0.029304	0.029304	0.019536	0.019536	0.019536	0.023443	0.00535
Average resilient def. (mm)	0.147289	0.147289	0.149744	0.149756	0.147289	0.148274	0.001348
Axial 1 resilient def. (mm)	0.139194	0.139194	0.141636	0.139194	0.139194	0.139683	0.001092
Axial 2 resilient def. (mm)	0.155385	0.155385	0.157851	0.160317	0.155385	0.156864	0.002206
Actuator resilient def. (mm)	0.21978	0.21978	0.227106	0.234432	0.227106	0.225641	0.006129
Average permanent def. (mm)	0.717326	0.71978	0.717326	0.718547	0.71978	0.718552	0.001227
Axial 1 permanent def. (mm)	0.719389	0.721832	0.719389	0.721832	0.721832	0.720855	0.001338
Axial 2 permanent def. (mm)	0.715263	0.717729	0.715263	0.715263	0.717729	0.716249	0.001351
Actuator permanent def. (mm)	0.747253	0.747253	0.739927	0.739927	0.747253	0.744322	0.004013
Sequence Number	23						
Cycle Number	196	197	198	199	200	Average	Std Dev.
Resilient Modulus (MPa)	232.71265	229.299598	230.741734	232.965691	236.494411	232.442817	2.717311
Resilient micro-strain	849.754234	862.402555	862.402555	843.49269	830.906985	849.791804	13.363932
Confining pressure (kPa)	40.43956	40.43956	40.14652	40.43956	40.43956	40.380952	0.131052
Maximum axial stress (kPa)	201.479664	201.479664	202.723366	200.235963	200.235963	201.230924	1.040555
Cyclic stress (kPa)	197.748559	197.748559	198.992261	196.504858	196.504858	197.499819	1.040555
Contact stress (kPa)	3.731105	3.731105	3.731105	3.731105	3.731105	3.731105	0
Permanent strain (%)	0.379187	0.378554	0.379813	0.379187	0.379813	0.379311	0.000526
Maximum load (kN)	1.582418	1.582418	1.592186	1.57265	1.57265	1.580464	0.008173
Cyclic load (kN)	1.553114	1.553114	1.562882	1.543346	1.543346	1.55116	0.008173
Contact load (kN)	0.029304	0.029304	0.029304	0.029304	0.029304	0.029304	0
Average resilient def. (mm)	0.165702	0.168168	0.168168	0.164481	0.162027	0.165709	0.002606
Axial 1 resilient def. (mm)	0.156288	0.156288	0.156288	0.153846	0.151404	0.154823	0.002184
Axial 2 resilient def. (mm)	0.175116	0.180049	0.180049	0.175116	0.17265	0.176596	0.003309
Actuator resilient def. (mm)	0.263736	0.271062	0.278388	0.263736	0.263736	0.268132	0.006553
Average permanent def. (mm)	0.739414	0.738181	0.740635	0.739414	0.740635	0.739656	0.001026
Axial 1 permanent def. (mm)	0.741368	0.741368	0.74381	0.741368	0.74381	0.742344	0.001338
Axial 2 permanent def. (mm)	0.73746	0.734994	0.73746	0.73746	0.73746	0.736967	0.001103

Actuator permanent def. (mm)	0.754579	0.754579	0.754579	0.754579	0.754579	0.754579	0
Sequence Number	24						
Cycle Number	196	197	198	199	200	Average	Std Dev.
Resilient Modulus (MPa)	269.793669	271.156263	271.156263	269.290424	270.303935	270.340111	0.826734
Resilient micro-strain	912.745374	912.745374	912.745374	919.069534	906.421214	912.745374	4.471857
Confining pressure (kPa)	50.40293	50.695971	50.40293	50.40293	50.40293	50.461538	0.131052
Maximum axial stress (kPa)	249.984028	251.227729	251.227729	251.227729	249.984028	250.730249	0.681203
Cyclic stress (kPa)	246.252923	247.496625	247.496625	247.496625	245.009221	246.750404	1.112401
Contact stress (kPa)	3.731105	3.731105	3.731105	3.731105	4.974807	3.979845	0.5562
Permanent strain (%)	0.389255	0.389255	0.389881	0.389881	0.389255	0.389506	0.000343
Maximum load (kN)	1.96337	1.973138	1.973138	1.973138	1.96337	1.969231	0.00535
Cyclic load (kN)	1.934066	1.943834	1.943834	1.943834	1.924298	1.937973	0.008737
Contact load (kN)	0.029304	0.029304	0.029304	0.029304	0.039072	0.031258	0.004368
Average resilient def. (mm)	0.177985	0.177985	0.177985	0.179219	0.176752	0.177985	0.000872
Axial 1 resilient def. (mm)	0.166056	0.166056	0.166056	0.166056	0.166056	0.166056	0
Axial 2 resilient def. (mm)	0.189915	0.189915	0.189915	0.192381	0.187448	0.189915	0.001744
Actuator resilient def. (mm)	0.300366	0.29304	0.300366	0.29304	0.285714	0.294505	0.006129
Average permanent def. (mm)	0.759048	0.759048	0.760269	0.760269	0.759048	0.759536	0.000669
Axial 1 permanent def. (mm)	0.760904	0.760904	0.763346	0.763346	0.760904	0.76188	0.001338
Axial 2 permanent def. (mm)	0.757192	0.757192	0.757192	0.757192	0.757192	0.757192	0
Actuator permanent def. (mm)	0.769231	0.769231	0.769231	0.776557	0.776557	0.772161	0.004013
Sequence Number	25						
Cycle Number	196	197	198	199	200	Average	Std Dev.
Resilient Modulus (MPa)	350.188273	351.622175	351.371342	355.628976	353.476749	352.457503	2.128616
Resilient micro-strain	1051.250744	1057.574904	1051.250744	1038.665039	1044.989199	1048.746126	7.180466
Confining pressure (kPa)	75.311355	75.311355	75.311355	75.311355	75.897436	75.428571	0.262103
Maximum axial stress (kPa)	374.354191	376.841594	374.354191	374.354191	374.354191	374.851672	1.112401
Cyclic stress (kPa)	368.135683	371.866788	369.379384	369.379384	369.379384	369.628125	1.362407
Contact stress (kPa)	6.218508	4.974807	4.974807	4.974807	4.974807	5.223547	0.5562
Permanent strain (%)	0.411909	0.413168	0.411909	0.413168	0.413168	0.412665	0.000689
Maximum load (kN)	2.940171	2.959707	2.940171	2.940171	2.940171	2.944078	0.008737
Cyclic load (kN)	2.891331	2.920635	2.901099	2.901099	2.901099	2.903053	0.0107
Contact load (kN)	0.04884	0.039072	0.039072	0.039072	0.039072	0.041026	0.004368
Average resilient def. (mm)	0.204994	0.206227	0.204994	0.20254	0.203773	0.204505	0.0014
Axial 1 resilient def. (mm)	0.190476	0.190476	0.190476	0.188034	0.188034	0.189499	0.001338
Axial 2 resilient def. (mm)	0.219512	0.221978	0.219512	0.217045	0.219512	0.219512	0.001744
Actuator resilient def. (mm)	0.358974	0.3663	0.351648	0.358974	0.358974	0.358974	0.00518
Average permanent def. (mm)	0.803223	0.805678	0.803223	0.805678	0.805678	0.804696	0.001344
Axial 1 permanent def. (mm)	0.80486	0.807302	0.80486	0.807302	0.807302	0.806325	0.001338
Axial 2 permanent def. (mm)	0.801587	0.804054	0.801587	0.804054	0.804054	0.803067	0.001351
Actuator permanent def. (mm)	0.813187	0.813187	0.820513	0.813187	0.820513	0.816117	0.004013
Sequence Number	26						
Cycle Number	196	197	198	199	200	Average	Std Dev.
Resilient Modulus (MPa)	425.211624	426.28539	428.602411	426.28539	420.618428	425.400649	2.946276
Resilient micro-strain	1158.260543	1158.260543	1151.998998	1158.260543	1170.908863	1159.537898	6.910658
Confining pressure (kPa)	100.512821	100.512821	100.21978	100.512821	100.512821	100.454212	0.131052
Maximum axial stress (kPa)	499.968056	499.968056	499.968056	499.968056	498.724354	499.719315	0.5562
Cyclic stress (kPa)	492.505846	493.749548	493.749548	493.749548	492.505846	493.252067	0.681203
Contact stress (kPa)	7.46221	6.218508	6.218508	6.218508	6.218508	6.467248	0.5562
Permanent strain (%)	0.44023	0.44023	0.44023	0.44023	0.439598	0.440104	0.000283
Maximum load (kN)	3.92674	3.92674	3.92674	3.92674	3.916972	3.924786	0.004368
Cyclic load (kN)	3.868132	3.8779	3.8779	3.8779	3.868132	3.873993	0.00535
Contact load (kN)	0.058608	0.04884	0.04884	0.04884	0.04884	0.050794	0.004368
Average resilient def. (mm)	0.225861	0.225861	0.22464	0.225861	0.228327	0.22611	0.001348
Axial 1 resilient def. (mm)	0.210012	0.210012	0.20757	0.210012	0.210012	0.209524	0.001092
Axial 2 resilient def. (mm)	0.241709	0.241709	0.241709	0.241709	0.246642	0.242696	0.002206
Actuator resilient def. (mm)	0.417582	0.417582	0.417582	0.417582	0.432234	0.420513	0.006553
Average permanent def. (mm)	0.858449	0.858449	0.858449	0.858449	0.857216	0.858203	0.000552
Axial 1 permanent def. (mm)	0.858584	0.858584	0.858584	0.858584	0.858584	0.858584	0
Axial 2 permanent def. (mm)	0.858315	0.858315	0.858315	0.858315	0.855849	0.857822	0.001103
Actuator permanent def. (mm)	0.857143	0.857143	0.857143	0.857143	0.849817	0.855678	0.003276
Sequence Number	27						
Cycle Number	196	197	198	199	200	Average	Std Dev.
Resilient Modulus (MPa)	264.335415	262.553061	262.12911	264.780063	264.780063	263.715542	1.276595
Resilient micro-strain	931.592624	937.916784	944.178329	925.331079	925.331079	932.869979	8.195283
Confining pressure (kPa)	50.40293	50.10989	50.40293	50.40293	50.40293	50.344322	0.131052
Maximum axial stress (kPa)	249.984028	251.227729	251.227729	249.984028	249.984028	250.481508	0.681203
Cyclic stress (kPa)	246.252923	246.252923	247.496625	245.009221	245.009221	246.004183	1.040555
Contact stress (kPa)	3.731105	4.974807	3.731105	4.974807	4.974807	4.477326	0.681203
Permanent strain (%)	0.408134	0.408134	0.408134	0.408134	0.408134	0.408134	0
Maximum load (kN)	1.96337	1.973138	1.973138	1.96337	1.96337	1.967277	0.00535
Cyclic load (kN)	1.934066	1.934066	1.943834	1.924298	1.924298	1.932112	0.008173
Contact load (kN)	0.029304	0.039072	0.029304	0.039072	0.039072	0.035165	0.00535
Average resilient def. (mm)	0.181661	0.182894	0.184115	0.18044	0.18044	0.18191	0.001598

Axial 1 resilient def. (mm)	0.17094	0.17094	0.173382	0.168498	0.168498	0.170452	0.002043
Axial 2 resilient def. (mm)	0.192381	0.194847	0.194847	0.192381	0.192381	0.193368	0.001351
Actuator resilient def. (mm)	0.29304	0.300366	0.300366	0.29304	0.29304	0.295971	0.004013
Average permanent def. (mm)	0.795861	0.795861	0.795861	0.795861	0.795861	0.795861	0
Axial 1 permanent def. (mm)	0.797534	0.797534	0.797534	0.797534	0.797534	0.797534	0
Axial 2 permanent def. (mm)	0.794188	0.794188	0.794188	0.794188	0.794188	0.794188	0
Actuator permanent def. (mm)	0.805861	0.805861	0.813187	0.805861	0.813187	0.808791	0.004013
Sequence Number	28						
Cycle Number	196	197	198	199	200	Average	Std Dev.
Resilient Modulus (MPa)	206.255376	203.321817	204.695149	206.240399	204.798159	205.06218	1.229349
Resilient micro-strain	862.277324	868.601484	874.925644	862.339939	862.339939	866.096866	5.635564
Confining pressure (kPa)	30.47619	30.47619	30.47619	30.47619	30.47619	30.47619	0
Maximum axial stress (kPa)	181.580438	180.336736	182.82414	181.580438	180.336736	181.331698	1.040555
Cyclic stress (kPa)	177.849333	176.605632	179.093035	177.849333	176.605632	177.600593	1.040555
Contact stress (kPa)	3.731105	3.731105	3.731105	3.731105	3.731105	3.731105	0
Permanent strain (%)	0.392405	0.391146	0.393031	0.391772	0.392405	0.392152	0.000717
Maximum load (kN)	1.426129	1.416361	1.435897	1.426129	1.416361	1.424176	0.008173
Cyclic load (kN)	1.396825	1.387057	1.406593	1.396825	1.387057	1.394872	0.008173
Contact load (kN)	0.029304	0.029304	0.029304	0.029304	0.029304	0.029304	0
Average resilient def. (mm)	0.168144	0.169377	0.170611	0.168156	0.168156	0.168889	0.001099
Axial 1 resilient def. (mm)	0.161172	0.161172	0.161172	0.15873	0.15873	0.160195	0.001338
Axial 2 resilient def. (mm)	0.175116	0.177582	0.180049	0.177582	0.177582	0.177582	0.001744
Actuator resilient def. (mm)	0.263736	0.25641	0.271062	0.263736	0.263736	0.263736	0.00518
Average permanent def. (mm)	0.765189	0.762735	0.76641	0.763956	0.765189	0.764696	0.001398
Axial 1 permanent def. (mm)	0.765788	0.763346	0.76823	0.765788	0.765788	0.765788	0.001727
Axial 2 permanent def. (mm)	0.764591	0.762125	0.764591	0.762125	0.764591	0.763604	0.001351
Actuator permanent def. (mm)	0.791209	0.791209	0.791209	0.791209	0.791209	0.791209	0
Sequence Number	29						
Cycle Number	196	197	198	199	200	Average	Std Dev.
Resilient Modulus (MPa)	287.283122	288.495288	286.727954	284.999324	287.283122	286.957762	1.271219
Resilient micro-strain	1026.016718	1026.016718	1032.340878	1038.602423	1026.016718	1029.798691	5.632015
Confining pressure (kPa)	50.40293	50.40293	50.10989	50.40293	50.40293	50.344322	0.131052
Maximum axial stress (kPa)	299.732093	300.975795	300.975795	300.975795	299.732093	300.478314	0.681203
Cyclic stress (kPa)	294.757287	296.000988	296.000988	296.000988	294.757287	295.503508	0.681203
Contact stress (kPa)	4.974807	4.974807	4.974807	4.974807	4.974807	4.974807	0
Permanent strain (%)	0.411283	0.411283	0.410651	0.410025	0.411283	0.410905	0.000563
Maximum load (kN)	2.35409	2.363858	2.363858	2.363858	2.35409	2.359951	0.00535
Cyclic load (kN)	2.315018	2.324786	2.324786	2.324786	2.315018	2.320879	0.00535
Contact load (kN)	0.039072	0.039072	0.039072	0.039072	0.039072	0.039072	0
Average resilient def. (mm)	0.200073	0.200073	0.201306	0.202527	0.200073	0.200811	0.001098
Axial 1 resilient def. (mm)	0.188034	0.188034	0.188034	0.190476	0.188034	0.188523	0.001092
Axial 2 resilient def. (mm)	0.212112	0.212112	0.214579	0.214579	0.212112	0.213099	0.001351
Actuator resilient def. (mm)	0.32967	0.32967	0.32967	0.32967	0.322344	0.328205	0.003276
Average permanent def. (mm)	0.802002	0.802002	0.800769	0.799548	0.802002	0.801265	0.001098
Axial 1 permanent def. (mm)	0.802418	0.802418	0.802418	0.799976	0.802418	0.801929	0.001092
Axial 2 permanent def. (mm)	0.801587	0.801587	0.799121	0.799121	0.801587	0.800601	0.001351
Actuator permanent def. (mm)	0.820513	0.820513	0.820513	0.820513	0.820513	0.820513	0
Sequence Number	30						
Cycle Number	196	197	198	199	200	Average	Std Dev.
Resilient Modulus (MPa)	379.214165	377.283108	381.27356	374.130325	379.214165	378.223065	2.688128
Resilient micro-strain	1170.846248	1183.431953	1164.522088	1183.431953	1170.846248	1174.615698	8.452088
Confining pressure (kPa)	75.604396	75.604396	75.604396	75.604396	75.604396	75.604396	0
Maximum axial stress (kPa)	450.21999	452.707394	450.21999	448.976289	450.21999	450.468731	1.362407
Cyclic stress (kPa)	444.001482	446.488886	444.001482	442.757781	444.001482	444.250223	1.362407
Contact stress (kPa)	6.218508	6.218508	6.218508	6.218508	6.218508	6.218508	0
Permanent strain (%)	0.435196	0.435196	0.435196	0.433938	0.435196	0.434944	0.000563
Maximum load (kN)	3.53602	3.555556	3.53602	3.526252	3.53602	3.537973	0.0107
Cyclic load (kN)	3.487179	3.506716	3.487179	3.477411	3.487179	3.489133	0.0107
Contact load (kN)	0.04884	0.04884	0.04884	0.04884	0.04884	0.04884	0
Average resilient def. (mm)	0.228315	0.230769	0.227082	0.230769	0.228315	0.22905	0.001648
Axial 1 resilient def. (mm)	0.212454	0.214896	0.212454	0.214896	0.212454	0.213431	0.001338
Axial 2 resilient def. (mm)	0.244176	0.246642	0.241709	0.246642	0.244176	0.244669	0.002064
Actuator resilient def. (mm)	0.410256	0.417582	0.40293	0.40293	0.40293	0.407326	0.006553
Average permanent def. (mm)	0.848632	0.848632	0.848632	0.846178	0.848632	0.848142	0.001098
Axial 1 permanent def. (mm)	0.848816	0.848816	0.848816	0.846374	0.848816	0.848327	0.001092
Axial 2 permanent def. (mm)	0.848449	0.848449	0.848449	0.845983	0.848449	0.847956	0.001103
Actuator permanent def. (mm)	0.849817	0.849817	0.857143	0.849817	0.857143	0.852747	0.004013
Sequence Number	31						
Cycle Number	196	197	198	199	200	Average	Std Dev.
Resilient Modulus (MPa)	286.745346	287.932694	284.999324	289.707453	286.727954	287.222554	1.738831
Resilient micro-strain	1032.278263	1032.340878	1038.602423	1026.016718	1032.340878	1032.315832	4.449796
Confining pressure (kPa)	50.989011	50.10989	50.40293	50.10989	50.40293	50.40293	0.3589
Maximum axial stress (kPa)	300.975795	300.975795	300.975795	300.975795	300.975795	300.975795	0
Cyclic stress (kPa)	296.000988	297.24469	296.000988	297.24469	296.000988	296.498469	0.681203

Contact stress (kPa)	4.974807	3.731105	4.974807	3.731105	4.974807	4.477326	0.681203
Permanent strain (%)	0.418835	0.418835	0.418835	0.418835	0.418835	0.418835	0
Maximum load (kN)	2.363858	2.363858	2.363858	2.363858	2.363858	2.363858	0
Cyclic load (kN)	2.324786	2.334554	2.324786	2.334554	2.324786	2.328694	0.00535
Contact load (kN)	0.039072	0.029304	0.039072	0.029304	0.039072	0.035165	0.00535
Average resilient def. (mm)	0.201294	0.201306	0.202527	0.200073	0.201306	0.201302	0.000868
Axial 1 resilient def. (mm)	0.190476	0.188034	0.190476	0.188034	0.188034	0.189011	0.001338
Axial 2 resilient def. (mm)	0.212112	0.214579	0.214579	0.212112	0.214579	0.213592	0.001351
Actuator resilient def. (mm)	0.32967	0.32967	0.336996	0.336996	0.32967	0.332601	0.004013
Average permanent def. (mm)	0.816728	0.816728	0.816728	0.816728	0.816728	0.816728	0
Axial 1 permanent def. (mm)	0.81707	0.81707	0.81707	0.81707	0.81707	0.81707	0
Axial 2 permanent def. (mm)	0.816386	0.816386	0.816386	0.816386	0.816386	0.816386	0
Actuator permanent def. (mm)	0.842491	0.842491	0.835165	0.835165	0.842491	0.83956	0.004013
Sequence Number	32						
Cycle Number	196	197	198	199	200	Average	Std Dev.
Resilient Modulus (MPa)	209.295024	207.831423	209.389773	206.170642	207.846738	208.10672	1.318149
Resilient micro-strain	849.754234	849.754234	843.430074	868.664099	849.691619	852.258852	9.56839
Confining pressure (kPa)	30.47619	30.47619	30.18315	30.47619	30.47619	30.417582	0.131052
Maximum axial stress (kPa)	181.580438	180.336736	179.093035	182.82414	180.336736	180.834217	1.418038
Cyclic stress (kPa)	177.849333	176.605632	176.605632	179.093035	176.605632	177.351853	1.112401
Contact stress (kPa)	3.731105	3.731105	2.487403	3.731105	3.731105	3.482365	0.5562
Permanent strain (%)	0.401841	0.401841	0.402473	0.401841	0.401215	0.401842	0.000445
Maximum load (kN)	1.426129	1.416361	1.406593	1.435897	1.416361	1.420269	0.011137
Cyclic load (kN)	1.396825	1.387057	1.387057	1.406593	1.387057	1.392918	0.008737
Contact load (kN)	0.029304	0.029304	0.019536	0.029304	0.029304	0.02735	0.004368
Average resilient def. (mm)	0.165702	0.165702	0.164469	0.169389	0.16569	0.16619	0.001866
Axial 1 resilient def. (mm)	0.156288	0.156288	0.156288	0.15873	0.15873	0.157265	0.001338
Axial 2 resilient def. (mm)	0.175116	0.175116	0.17265	0.180049	0.17265	0.175116	0.003021
Actuator resilient def. (mm)	0.263736	0.25641	0.249084	0.271062	0.25641	0.259341	0.008353
Average permanent def. (mm)	0.78359	0.78359	0.784823	0.78359	0.782369	0.783592	0.000868
Axial 1 permanent def. (mm)	0.785324	0.785324	0.785324	0.785324	0.782882	0.784835	0.001092
Axial 2 permanent def. (mm)	0.781856	0.781856	0.784322	0.781856	0.781856	0.782349	0.001103
Actuator permanent def. (mm)	0.805861	0.805861	0.813187	0.805861	0.805861	0.807326	0.003276
Sequence Number	33						
Cycle Number	196	197	198	199	200	Average	Std Dev.
Resilient Modulus (MPa)	252.739941	259.076568	253.667363	254.399569	252.049792	254.386647	2.769721
Resilient micro-strain	969.412354	950.502489	975.673899	963.088194	981.935443	968.122476	12.096423
Confining pressure (kPa)	40.43956	40.43956	40.43956	40.14652	40.732601	40.43956	0.207211
Maximum axial stress (kPa)	249.984028	249.984028	251.227729	249.984028	251.227729	250.481508	0.681203
Cyclic stress (kPa)	245.009221	246.252923	247.496625	245.009221	247.496625	246.252923	1.243702
Contact stress (kPa)	4.974807	3.731105	3.731105	4.974807	3.731105	4.228586	0.681203
Permanent strain (%)	0.410651	0.411909	0.410651	0.410651	0.410651	0.410903	0.000563
Maximum load (kN)	1.96337	1.96337	1.973138	1.96337	1.973138	1.967277	0.00535
Cyclic load (kN)	1.924298	1.934066	1.943834	1.924298	1.943834	1.934066	0.009768
Contact load (kN)	0.039072	0.029304	0.029304	0.039072	0.029304	0.033211	0.00535
Average resilient def. (mm)	0.189035	0.185348	0.190256	0.187802	0.191477	0.188784	0.002359
Axial 1 resilient def. (mm)	0.175824	0.173382	0.178266	0.175824	0.180708	0.176801	0.002784
Axial 2 resilient def. (mm)	0.202247	0.197314	0.202247	0.19978	0.202247	0.200767	0.002206
Actuator resilient def. (mm)	0.300366	0.300366	0.307692	0.300366	0.315018	0.304762	0.006553
Average permanent def. (mm)	0.800769	0.803223	0.800769	0.800769	0.800769	0.80126	0.001098
Axial 1 permanent def. (mm)	0.802418	0.80486	0.802418	0.802418	0.802418	0.802906	0.001092
Axial 2 permanent def. (mm)	0.799121	0.801587	0.799121	0.799121	0.799121	0.799614	0.001103
Actuator permanent def. (mm)	0.820513	0.820513	0.820513	0.820513	0.813187	0.819048	0.003276
Sequence Number	34						
Cycle Number	196	197	198	199	200	Average	Std Dev.
Resilient Modulus (MPa)	221.61454	220.13494	222.949567	224.649528	221.461054	222.161926	1.710853
Resilient micro-strain	931.592624	937.854169	931.592624	919.006919	937.854169	931.580101	7.694366
Confining pressure (kPa)	30.47619	30.47619	29.89011	30.47619	30.18315	30.300366	0.262103
Maximum axial stress (kPa)	210.185576	210.185576	210.185576	210.185576	211.429277	210.434316	0.5562
Cyclic stress (kPa)	206.454471	206.454471	207.698172	206.454471	207.698172	206.951951	0.681203
Contact stress (kPa)	3.731105	3.731105	2.487403	3.731105	3.731105	3.482365	0.5562
Permanent strain (%)	0.404358	0.403099	0.404358	0.404358	0.403099	0.403855	0.000689
Maximum load (kN)	1.650794	1.650794	1.650794	1.650794	1.660562	1.652747	0.004368
Cyclic load (kN)	1.62149	1.62149	1.631258	1.62149	1.631258	1.625397	0.00535
Contact load (kN)	0.029304	0.029304	0.019536	0.029304	0.029304	0.02735	0.004368
Average resilient def. (mm)	0.181661	0.182882	0.181661	0.179206	0.182882	0.181658	0.0015
Axial 1 resilient def. (mm)	0.17094	0.173382	0.17094	0.168498	0.173382	0.171429	0.002043
Axial 2 resilient def. (mm)	0.192381	0.192381	0.192381	0.189915	0.192381	0.191888	0.001103
Actuator resilient def. (mm)	0.278388	0.285714	0.285714	0.278388	0.285714	0.282784	0.004013
Average permanent def. (mm)	0.788498	0.786044	0.788498	0.788498	0.786044	0.787516	0.001344
Axial 1 permanent def. (mm)	0.790208	0.787766	0.790208	0.790208	0.787766	0.789231	0.001338
Axial 2 permanent def. (mm)	0.786789	0.784322	0.786789	0.786789	0.784322	0.785802	0.001351
Actuator permanent def. (mm)	0.813187	0.813187	0.813187	0.813187	0.813187	0.813187	0
Sequence Number	35						

Appendix C: Red Sand Stabilisation

Cycle Number	196	197	198	199	200	Average	Std Dev.
Resilient Modulus (MPa)	270.769616	270.769616	267.888481	269.100646	270.312811	269.768234	1.25312
Resilient micro-strain	1019.692558	1019.692558	1026.016718	1026.016718	1026.016718	1023.487054	3.463885
Confining pressure (kPa)	40.43956	40.14652	40.43956	40.43956	40.14652	40.322344	0.160505
Maximum axial stress (kPa)	281.076569	281.076569	279.832867	279.832867	281.076569	280.579088	0.681203
Cyclic stress (kPa)	276.101762	276.101762	274.85806	276.101762	277.345464	276.101762	0.87943
Contact stress (kPa)	4.974807	4.974807	4.974807	3.731105	3.731105	4.477326	0.681203
Permanent strain (%)	0.4138	0.4138	0.412542	0.412542	0.412542	0.413045	0.000689
Maximum load (kN)	2.20757	2.20757	2.197802	2.197802	2.20757	2.203663	0.00535
Cyclic load (kN)	2.168498	2.168498	2.15873	2.168498	2.178266	2.168498	0.006907
Contact load (kN)	0.039072	0.039072	0.039072	0.029304	0.029304	0.035165	0.00535
Average resilient def. (mm)	0.19884	0.19884	0.200073	0.200073	0.200073	0.19958	0.000675
Axial 1 resilient def. (mm)	0.188034	0.188034	0.188034	0.188034	0.188034	0.188034	0
Axial 2 resilient def. (mm)	0.209646	0.209646	0.212112	0.212112	0.212112	0.211126	0.001351
Actuator resilient def. (mm)	0.322344	0.32967	0.322344	0.32967	0.322344	0.325275	0.004013
Average permanent def. (mm)	0.806911	0.806911	0.804457	0.804457	0.804457	0.805438	0.001344
Axial 1 permanent def. (mm)	0.807302	0.807302	0.80486	0.80486	0.80486	0.805836	0.001338
Axial 2 permanent def. (mm)	0.80652	0.80652	0.804054	0.804054	0.804054	0.80504	0.001351
Actuator permanent def. (mm)	0.827839	0.827839	0.820513	0.820513	0.827839	0.824908	0.004013

Sequence Number	36						
Cycle Number	196	197	198	199	200	Average	Std Dev.
Resilient Modulus (MPa)	313.86263	318.19575	313.403852	310.966072	319.344472	315.154555	3.502916
Resilient micro-strain	1101.593563	1082.683698	1095.269403	1107.855108	1082.683698	1094.017094	11.262255
Confining pressure (kPa)	50.10989	50.695971	50.40293	50.40293	50.40293	50.40293	0.207211
Maximum axial stress (kPa)	350.72386	349.480158	349.480158	349.480158	350.72386	349.977639	0.681203
Cyclic stress (kPa)	345.749053	344.505352	343.26165	344.505352	345.749053	344.754092	1.040555
Contact stress (kPa)	4.974807	4.974807	6.218508	4.974807	4.974807	5.223547	0.5562
Permanent strain (%)	0.42261	0.423869	0.42261	0.42261	0.423869	0.423114	0.000689
Maximum load (kN)	2.754579	2.744811	2.744811	2.744811	2.754579	2.748718	0.00535
Cyclic load (kN)	2.715507	2.705739	2.695971	2.705739	2.715507	2.707692	0.008173
Contact load (kN)	0.039072	0.039072	0.04884	0.039072	0.039072	0.041026	0.004368
Average resilient def. (mm)	0.214811	0.211123	0.213578	0.216032	0.211123	0.213333	0.002196
Axial 1 resilient def. (mm)	0.200244	0.197802	0.200244	0.202686	0.197802	0.199756	0.002043
Axial 2 resilient def. (mm)	0.229377	0.224444	0.226911	0.229377	0.224444	0.226911	0.002466
Actuator resilient def. (mm)	0.3663	0.351648	0.351648	0.3663	0.351648	0.357509	0.008025
Average permanent def. (mm)	0.82409	0.826545	0.82409	0.82409	0.826545	0.825072	0.001344
Axial 1 permanent def. (mm)	0.824396	0.826838	0.824396	0.824396	0.826838	0.825372	0.001338
Axial 2 permanent def. (mm)	0.823785	0.826252	0.823785	0.823785	0.826252	0.824772	0.001351
Actuator permanent def. (mm)	0.835165	0.842491	0.842491	0.835165	0.842491	0.83956	0.004013

Sequence Number	37						
Cycle Number	196	197	198	199	200	Average	Std Dev.
Resilient Modulus (MPa)	404.131636	403.162496	401.204921	404.131636	397.346254	401.995389	2.860443
Resilient micro-strain	1283.303591	1283.303591	1289.565136	1283.303591	1302.088225	1288.312827	8.164055
Confining pressure (kPa)	75.311355	75.311355	75.311355	75.018315	75.018315	75.194139	0.160505
Maximum axial stress (kPa)	524.842088	523.598387	524.842088	524.842088	524.842088	524.593348	0.5562
Cyclic stress (kPa)	518.62358	517.379878	517.379878	518.62358	517.379878	517.877359	0.681203
Contact stress (kPa)	6.218508	6.218508	7.46221	6.218508	7.46221	6.715989	0.681203
Permanent strain (%)	0.454707	0.454707	0.454707	0.454707	0.454707	0.454707	0
Maximum load (kN)	4.1221	4.112332	4.1221	4.1221	4.1221	4.120147	0.004368
Cyclic load (kN)	4.07326	4.063492	4.063492	4.07326	4.063492	4.067399	0.00535
Contact load (kN)	0.04884	0.04884	0.058608	0.04884	0.058608	0.052747	0.00535
Average resilient def. (mm)	0.250244	0.250244	0.251465	0.250244	0.253907	0.251221	0.001592
Axial 1 resilient def. (mm)	0.234432	0.234432	0.234432	0.234432	0.236874	0.234921	0.001092
Axial 2 resilient def. (mm)	0.266056	0.266056	0.268498	0.266056	0.27094	0.267521	0.002184
Actuator resilient def. (mm)	0.454212	0.43956	0.454212	0.446886	0.454212	0.449817	0.006553
Average permanent def. (mm)	0.886679	0.886679	0.886679	0.886679	0.886679	0.886679	0
Axial 1 permanent def. (mm)	0.885446	0.885446	0.885446	0.885446	0.885446	0.885446	0
Axial 2 permanent def. (mm)	0.887912	0.887912	0.887912	0.887912	0.887912	0.887912	0
Actuator permanent def. (mm)	0.893773	0.901099	0.893773	0.901099	0.893773	0.896703	0.004013

Sequence Number	38						
Cycle Number	196	197	198	199	200	Average	Std Dev.
Resilient Modulus (MPa)	262.277696	262.65685	263.056311	261.101563	260.733796	261.965243	1.003591
Resilient micro-strain	1057.449673	1051.188128	1044.863968	1057.449673	1063.711218	1054.932532	7.161247
Confining pressure (kPa)	40.43956	40.43956	40.43956	40.43956	40.14652	40.380952	0.131052
Maximum axial stress (kPa)	281.076569	279.832867	279.832867	279.832867	281.076569	280.330348	0.681203
Cyclic stress (kPa)	277.345464	276.101762	274.85806	276.101762	277.345464	276.350502	1.040555
Contact stress (kPa)	3.731105	3.731105	4.974807	3.731105	3.731105	3.979845	0.5562
Permanent strain (%)	0.429536	0.430162	0.429536	0.429536	0.429536	0.429661	0.00028
Maximum load (kN)	2.20757	2.197802	2.197802	2.197802	2.20757	2.201709	0.00535
Cyclic load (kN)	2.178266	2.168498	2.15873	2.168498	2.178266	2.170452	0.008173
Contact load (kN)	0.029304	0.029304	0.039072	0.029304	0.029304	0.031258	0.004368
Average resilient def. (mm)	0.206203	0.204982	0.203748	0.206203	0.207424	0.205712	0.001396
Axial 1 resilient def. (mm)	0.19536	0.192918	0.192918	0.19536	0.197802	0.194872	0.002043
Axial 2 resilient def. (mm)	0.217045	0.217045	0.214579	0.217045	0.217045	0.216552	0.001103
Actuator resilient def. (mm)	0.32967	0.322344	0.32967	0.32967	0.336996	0.32967	0.00518

Average permanent def. (mm)	0.837595	0.838816	0.837595	0.837595	0.837595	0.837839	0.000546
Axial 1 permanent def. (mm)	0.836606	0.839048	0.836606	0.836606	0.836606	0.837094	0.001092
Axial 2 permanent def. (mm)	0.838584	0.838584	0.838584	0.838584	0.838584	0.838584	0
Actuator permanent def. (mm)	0.864469	0.864469	0.857143	0.857143	0.857143	0.860073	0.004013
Sequence Number	39						
Cycle Number	196	197	198	199	200	Average	Std Dev.
Resilient Modulus (MPa)	176.800201	179.498929	177.990534	179.352568	176.635719	178.05559	1.356618
Resilient micro-strain	837.105914	824.520209	824.520209	818.258664	830.844369	827.049873	7.169482
Confining pressure (kPa)	20.21978	20.21978	20.21978	20.512821	19.92674	20.21978	0.207211
Maximum axial stress (kPa)	151.731599	150.487897	150.487897	150.487897	149.244196	150.487897	0.87943
Cyclic stress (kPa)	148.000494	148.000494	146.756792	146.756792	146.756792	147.254273	0.681203
Contact stress (kPa)	3.731105	2.487403	3.731105	3.731105	2.487403	3.233624	0.681203
Permanent strain (%)	0.410025	0.411283	0.411283	0.411283	0.410025	0.41078	0.000689
Maximum load (kN)	1.191697	1.181929	1.181929	1.181929	1.172161	1.181929	0.006907
Cyclic load (kN)	1.162393	1.162393	1.152625	1.152625	1.152625	1.156532	0.00535
Contact load (kN)	0.029304	0.019536	0.029304	0.029304	0.019536	0.025397	0.00535
Average resilient def. (mm)	0.163236	0.160781	0.160781	0.15956	0.162015	0.161275	0.001398
Axial 1 resilient def. (mm)	0.156288	0.153846	0.153846	0.151404	0.153846	0.153846	0.001727
Axial 2 resilient def. (mm)	0.170183	0.167717	0.167717	0.167717	0.170183	0.168703	0.001351
Actuator resilient def. (mm)	0.234432	0.241758	0.241758	0.241758	0.241758	0.240293	0.003276
Average permanent def. (mm)	0.799548	0.802002	0.802002	0.802002	0.799548	0.801021	0.001344
Axial 1 permanent def. (mm)	0.799976	0.802418	0.802418	0.802418	0.799976	0.801441	0.001338
Axial 2 permanent def. (mm)	0.799121	0.801587	0.801587	0.801587	0.799121	0.800601	0.001351
Actuator permanent def. (mm)	0.827839	0.827839	0.827839	0.827839	0.820513	0.826374	0.003276
Sequence Number	40						
Cycle Number	196	197	198	199	200	Average	Std Dev.
Resilient Modulus (MPa)	235.39881	236.618493	235.39881	236.618493	233.298809	235.466683	1.356671
Resilient micro-strain	1019.692558	1019.692558	1019.692558	1019.692558	1044.863968	1024.72684	11.256997
Confining pressure (kPa)	30.47619	30.47619	30.18315	30.18315	30.47619	30.358974	0.160505
Maximum axial stress (kPa)	245.009221	246.252923	245.009221	245.009221	247.496625	245.755442	1.112401
Cyclic stress (kPa)	240.034415	241.278116	240.034415	241.278116	243.76552	241.278116	1.523217
Contact stress (kPa)	4.974807	4.974807	4.974807	3.731105	3.731105	4.477326	0.681203
Permanent strain (%)	0.421352	0.42261	0.421352	0.42261	0.420093	0.421604	0.001053
Maximum load (kN)	1.924298	1.934066	1.924298	1.924298	1.943834	1.930159	0.008737
Cyclic load (kN)	1.885226	1.894994	1.885226	1.894994	1.91453	1.894994	0.011963
Contact load (kN)	0.039072	0.039072	0.039072	0.029304	0.029304	0.035165	0.00535
Average resilient def. (mm)	0.19884	0.19884	0.19884	0.19884	0.203748	0.199822	0.002195
Axial 1 resilient def. (mm)	0.188034	0.188034	0.188034	0.188034	0.192918	0.189011	0.002184
Axial 2 resilient def. (mm)	0.209646	0.209646	0.209646	0.209646	0.214579	0.210632	0.002206
Actuator resilient def. (mm)	0.307692	0.307692	0.307692	0.315018	0.315018	0.310623	0.004013
Average permanent def. (mm)	0.821636	0.82409	0.821636	0.82409	0.819182	0.822127	0.002053
Axial 1 permanent def. (mm)	0.821954	0.824396	0.821954	0.824396	0.819512	0.822442	0.002043
Axial 2 permanent def. (mm)	0.821319	0.823785	0.821319	0.823785	0.818852	0.821812	0.002064
Actuator permanent def. (mm)	0.842491	0.849817	0.842491	0.842491	0.842491	0.843956	0.003276
Sequence Number	41						
Cycle Number	196	197	198	199	200	Average	Std Dev.
Resilient Modulus (MPa)	283.703217	285.288771	285.288771	283.703217	282.599313	284.116658	1.161023
Resilient micro-strain	1126.639742	1120.378197	1120.378197	1126.639742	1126.639742	1124.135124	3.429589
Confining pressure (kPa)	40.732601	40.43956	40.732601	40.732601	40.43956	40.615385	0.160505
Maximum axial stress (kPa)	324.606126	324.606126	324.606126	324.606126	324.606126	324.606126	0
Cyclic stress (kPa)	319.631319	319.631319	319.631319	319.631319	318.387618	319.382579	0.5562
Contact stress (kPa)	4.974807	4.974807	4.974807	4.974807	6.218508	5.223547	0.5562
Permanent strain (%)	0.432685	0.432685	0.433311	0.432685	0.432685	0.43281	0.00028
Maximum load (kN)	2.549451	2.549451	2.549451	2.549451	2.549451	2.549451	0
Cyclic load (kN)	2.510379	2.510379	2.510379	2.510379	2.500611	2.508425	0.004368
Contact load (kN)	0.039072	0.039072	0.039072	0.039072	0.04884	0.041026	0.004368
Average resilient def. (mm)	0.219695	0.218474	0.218474	0.219695	0.219695	0.219206	0.000669
Axial 1 resilient def. (mm)	0.210012	0.20757	0.20757	0.210012	0.210012	0.209035	0.001338
Axial 2 resilient def. (mm)	0.229377	0.229377	0.229377	0.229377	0.229377	0.229377	0
Actuator resilient def. (mm)	0.351648	0.344322	0.351648	0.351648	0.358974	0.351648	0.00518
Average permanent def. (mm)	0.843736	0.843736	0.844957	0.843736	0.843736	0.84398	0.000546
Axial 1 permanent def. (mm)	0.84149	0.84149	0.843932	0.84149	0.84149	0.841978	0.001092
Axial 2 permanent def. (mm)	0.845983	0.845983	0.845983	0.845983	0.845983	0.845983	0
Actuator permanent def. (mm)	0.871795	0.871795	0.871795	0.871795	0.864469	0.87033	0.003276
Sequence Number	42						
Cycle Number	196	197	198	199	200	Average	Std Dev.
Resilient Modulus (MPa)	334.951814	322.226647	328.973267	328.633	326.239596	328.204865	4.634016
Resilient micro-strain	1177.045177	1227.387997	1202.216587	1195.892427	1208.478132	1202.204064	18.346668
Confining pressure (kPa)	50.40293	50.40293	50.40293	50.10989	50.989011	50.461538	0.32101
Maximum axial stress (kPa)	400.471925	401.715627	401.715627	399.228224	400.471925	400.720666	1.040555
Cyclic stress (kPa)	394.253417	395.497119	395.497119	393.009715	394.253417	394.502157	1.040555
Contact stress (kPa)	6.218508	6.218508	6.218508	6.218508	6.218508	6.218508	0
Permanent strain (%)	0.444012	0.442754	0.444012	0.443386	0.442754	0.443384	0.000629
Maximum load (kN)	3.145299	3.155067	3.155067	3.135531	3.145299	3.147253	0.008173

Cyclic load (kN)	3.096459	3.106227	3.106227	3.086691	3.096459	3.098413	0.008173
Contact load (kN)	0.04884	0.04884	0.04884	0.04884	0.04884	0.04884	0
Average resilient def. (mm)	0.229524	0.239341	0.234432	0.233199	0.235653	0.23443	0.003578
Axial 1 resilient def. (mm)	0.217338	0.227106	0.222222	0.222222	0.224664	0.222711	0.003622
Axial 2 resilient def. (mm)	0.241709	0.251575	0.246642	0.244176	0.246642	0.246149	0.003658
Actuator resilient def. (mm)	0.380952	0.395604	0.395604	0.388278	0.40293	0.392674	0.008353
Average permanent def. (mm)	0.865824	0.86337	0.865824	0.864603	0.86337	0.864598	0.001227
Axial 1 permanent def. (mm)	0.863468	0.861026	0.863468	0.861026	0.861026	0.862002	0.001338
Axial 2 permanent def. (mm)	0.868181	0.865714	0.868181	0.868181	0.865714	0.867194	0.001351
Actuator permanent def. (mm)	0.886447	0.886447	0.886447	0.886447	0.879121	0.884982	0.003276
Sequence Number	43						
Cycle Number	196	197	198	199	200	Average	Std Dev.
Resilient Modulus (MPa)	236.618493	235.39881	235.174376	233.962137	230.535751	234.337914	2.325073
Resilient micro-strain	1019.692558	1019.692558	1025.954103	1025.954103	1057.387057	1029.736076	15.771239
Confining pressure (kPa)	30.18315	30.47619	30.47619	30.47619	30.47619	30.417582	0.131052
Maximum axial stress (kPa)	246.252923	245.009221	245.009221	243.76552	247.496625	245.506702	1.418038
Cyclic stress (kPa)	241.278116	240.034415	241.278116	240.034415	243.76552	241.278116	1.523217
Contact stress (kPa)	4.974807	4.974807	3.731105	3.731105	3.731105	4.228586	0.681203
Permanent strain (%)	0.427645	0.427645	0.427019	0.427019	0.427019	0.427269	0.000343
Maximum load (kN)	1.934066	1.924298	1.924298	1.91453	1.943834	1.928205	0.011137
Cyclic load (kN)	1.894994	1.885226	1.894994	1.885226	1.91453	1.894994	0.011963
Contact load (kN)	0.039072	0.039072	0.029304	0.029304	0.029304	0.033211	0.00535
Average resilient def. (mm)	0.19884	0.19884	0.200061	0.200061	0.20619	0.200799	0.003075
Axial 1 resilient def. (mm)	0.188034	0.188034	0.190476	0.190476	0.197802	0.190965	0.004013
Axial 2 resilient def. (mm)	0.209646	0.209646	0.209646	0.209646	0.214579	0.210632	0.002206
Actuator resilient def. (mm)	0.315018	0.315018	0.315018	0.315018	0.336996	0.319414	0.009829
Average permanent def. (mm)	0.833907	0.833907	0.832686	0.832686	0.832686	0.833175	0.000669
Axial 1 permanent def. (mm)	0.834164	0.834164	0.831722	0.831722	0.831722	0.832698	0.001338
Axial 2 permanent def. (mm)	0.833651	0.833651	0.833651	0.833651	0.833651	0.833651	0
Actuator permanent def. (mm)	0.857143	0.849817	0.849817	0.849817	0.849817	0.851282	0.003276
Sequence Number	44						
Cycle Number	196	197	198	199	200	Average	Std Dev.
Resilient Modulus (MPa)	193.625585	196.27799	197.603744	194.940198	197.596783	196.00886	1.729134
Resilient micro-strain	937.791553	937.791553	925.205848	931.467393	918.944304	930.24013	8.192891
Confining pressure (kPa)	20.21978	20.512821	20.512821	20.805861	20.21978	20.454212	0.245175
Maximum axial stress (kPa)	185.311543	186.555245	186.555245	185.311543	185.311543	185.809024	0.681203
Cyclic stress (kPa)	181.580438	184.067841	182.82414	181.580438	181.580438	182.326659	1.112401
Contact stress (kPa)	3.731105	2.487403	3.731105	3.731105	3.731105	3.482365	0.5562
Permanent strain (%)	0.418209	0.419467	0.419467	0.418841	0.419467	0.41909	0.000563
Maximum load (kN)	1.455433	1.465201	1.465201	1.455433	1.455433	1.459341	0.00535
Cyclic load (kN)	1.426129	1.445665	1.435897	1.426129	1.426129	1.43199	0.008737
Contact load (kN)	0.029304	0.019536	0.029304	0.029304	0.029304	0.02735	0.004368
Average resilient def. (mm)	0.182869	0.182869	0.180415	0.181636	0.179194	0.181397	0.001598
Axial 1 resilient def. (mm)	0.175824	0.175824	0.173382	0.175824	0.17094	0.174359	0.002184
Axial 2 resilient def. (mm)	0.189915	0.189915	0.187448	0.187448	0.187448	0.188435	0.001351
Actuator resilient def. (mm)	0.278388	0.278388	0.271062	0.271062	0.271062	0.273993	0.004013
Average permanent def. (mm)	0.815507	0.817961	0.817961	0.81674	0.817961	0.817226	0.001097
Axial 1 permanent def. (mm)	0.814628	0.81707	0.81707	0.814628	0.81707	0.816093	0.001338
Axial 2 permanent def. (mm)	0.816386	0.818852	0.818852	0.818852	0.818852	0.818359	0.001103
Actuator permanent def. (mm)	0.842491	0.849817	0.849817	0.849817	0.849817	0.848352	0.003276
Sequence Number	45						
Cycle Number	196	197	198	199	200	Average	Std Dev.
Resilient Modulus (MPa)	253.718537	252.233761	252.219001	251.907211	253.3813	252.691962	0.802888
Resilient micro-strain	1063.711218	1069.972762	1070.035378	1076.296922	1070.035378	1070.010332	4.449796
Confining pressure (kPa)	30.18315	30.47619	30.769231	30.47619	30.47619	30.47619	0.207211
Maximum axial stress (kPa)	274.85806	274.85806	274.85806	274.85806	274.85806	274.85806	0
Cyclic stress (kPa)	269.883254	269.883254	269.883254	271.126956	271.126956	270.380735	0.681203
Contact stress (kPa)	4.974807	4.974807	4.974807	3.731105	3.731105	4.477326	0.681203
Permanent strain (%)	0.430794	0.430168	0.429536	0.430168	0.429536	0.43004	0.000527
Maximum load (kN)	2.15873	2.15873	2.15873	2.15873	2.15873	2.15873	0
Cyclic load (kN)	2.119658	2.119658	2.119658	2.129426	2.129426	2.123565	0.00535
Contact load (kN)	0.039072	0.039072	0.039072	0.029304	0.029304	0.035165	0.00535
Average resilient def. (mm)	0.207424	0.208645	0.208657	0.209878	0.208657	0.208652	0.000868
Axial 1 resilient def. (mm)	0.197802	0.200244	0.197802	0.200244	0.197802	0.198779	0.001338
Axial 2 resilient def. (mm)	0.217045	0.217045	0.219512	0.219512	0.219512	0.218525	0.001351
Actuator resilient def. (mm)	0.32967	0.32967	0.32967	0.336996	0.32967	0.331136	0.003276
Average permanent def. (mm)	0.840049	0.838828	0.837595	0.838828	0.837595	0.838579	0.001027
Axial 1 permanent def. (mm)	0.839048	0.836606	0.836606	0.836606	0.836606	0.837094	0.001092
Axial 2 permanent def. (mm)	0.84105	0.84105	0.838584	0.84105	0.838584	0.840063	0.001351
Actuator permanent def. (mm)	0.864469	0.864469	0.857143	0.857143	0.857143	0.860073	0.004013
Sequence Number	46						
Cycle Number	196	197	198	199	200	Average	Std Dev.
Resilient Modulus (MPa)	309.005495	315.721553	311.265086	307.362801	311.265086	310.924004	3.146903
Resilient micro-strain	1183.306722	1158.135312	1170.721017	1189.630882	1170.721017	1174.50299	12.276668

Confining pressure (kPa)	40.43956	40.732601	40.43956	40.43956	40.14652	40.43956	0.207211
Maximum axial stress (kPa)	370.623086	370.623086	370.623086	370.623086	369.379384	370.374346	0.5562
Cyclic stress (kPa)	365.64828	365.64828	364.404578	365.64828	364.404578	365.150799	0.681203
Contact stress (kPa)	4.974807	4.974807	6.218508	4.974807	4.974807	5.223547	0.5562
Permanent strain (%)	0.441495	0.442754	0.441495	0.440863	0.441495	0.44162	0.00069
Maximum load (kN)	2.910867	2.910867	2.910867	2.910867	2.901099	2.908913	0.004368
Cyclic load (kN)	2.871795	2.871795	2.862027	2.871795	2.862027	2.867888	0.00535
Contact load (kN)	0.039072	0.039072	0.04884	0.039072	0.039072	0.041026	0.004368
Average resilient def. (mm)	0.230745	0.225836	0.228291	0.231978	0.228291	0.229028	0.002394
Axial 1 resilient def. (mm)	0.21978	0.214896	0.217338	0.21978	0.217338	0.217827	0.002043
Axial 2 resilient def. (mm)	0.241709	0.236777	0.239243	0.244176	0.239243	0.24023	0.002812
Actuator resilient def. (mm)	0.380952	0.373626	0.373626	0.388278	0.380952	0.379487	0.006129
Average permanent def. (mm)	0.860916	0.86337	0.860916	0.859683	0.860916	0.86116	0.001346
Axial 1 permanent def. (mm)	0.858584	0.861026	0.858584	0.858584	0.858584	0.859072	0.001092
Axial 2 permanent def. (mm)	0.863248	0.865714	0.863248	0.860781	0.863248	0.863248	0.001744
Actuator permanent def. (mm)	0.879121	0.879121	0.879121	0.871795	0.879121	0.877656	0.003276
Sequence Number	47						
Cycle Number	196	197	198	199	200	Average	Std Dev.
Resilient Modulus (MPa)	351.122836	350.121962	347.662565	350.354169	349.375526	349.727411	1.311785
Resilient micro-strain	1264.518957	1264.581572	1277.104662	1270.843117	1270.843117	1269.578285	5.253805
Confining pressure (kPa)	50.40293	50.40293	50.695971	50.695971	50.40293	50.520147	0.160505
Maximum axial stress (kPa)	450.21999	448.976289	450.21999	451.463692	450.21999	450.21999	0.87943
Cyclic stress (kPa)	444.001482	442.757781	444.001482	445.245184	444.001482	444.001482	0.87943
Contact stress (kPa)	6.218508	6.218508	6.218508	6.218508	6.218508	6.218508	0
Permanent strain (%)	0.453455	0.452822	0.452822	0.452822	0.452822	0.452949	0.000283
Maximum load (kN)	3.53602	3.526252	3.53602	3.545788	3.53602	3.53602	0.006907
Cyclic load (kN)	3.487179	3.477411	3.487179	3.496947	3.487179	3.487179	0.006907
Contact load (kN)	0.04884	0.04884	0.04884	0.04884	0.04884	0.04884	0
Average resilient def. (mm)	0.246581	0.246593	0.249035	0.247814	0.247814	0.247568	0.001024
Axial 1 resilient def. (mm)	0.234432	0.234432	0.236874	0.234432	0.234432	0.234921	0.001092
Axial 2 resilient def. (mm)	0.25873	0.258755	0.261197	0.261197	0.261197	0.260215	0.001344
Actuator resilient def. (mm)	0.417582	0.417582	0.424908	0.424908	0.424908	0.421978	0.004013
Average permanent def. (mm)	0.884237	0.883004	0.883004	0.883004	0.883004	0.88325	0.000552
Axial 1 permanent def. (mm)	0.880562	0.880562	0.880562	0.880562	0.880562	0.880562	0
Axial 2 permanent def. (mm)	0.887912	0.885446	0.885446	0.885446	0.885446	0.885939	0.001103
Actuator permanent def. (mm)	0.908425	0.908425	0.908425	0.908425	0.908425	0.908425	0
Sequence Number	48						
Cycle Number	196	197	198	199	200	Average	Std Dev.
Resilient Modulus (MPa)	250.137756	251.584475	251.907211	252.219001	249.2869	251.027069	1.257489
Resilient micro-strain	1088.882627	1082.621083	1076.296922	1070.035378	1082.621083	1080.091419	7.169482
Confining pressure (kPa)	30.769231	30.18315	30.47619	30.18315	30.47619	30.417582	0.245175
Maximum axial stress (kPa)	276.101762	276.101762	274.85806	274.85806	274.85806	275.355541	0.681203
Cyclic stress (kPa)	272.370657	272.370657	271.126956	269.883254	269.883254	271.126956	1.243702
Contact stress (kPa)	3.731105	3.731105	3.731105	4.974807	4.974807	4.228586	0.681203
Permanent strain (%)	0.437087	0.437087	0.43772	0.438346	0.437087	0.437465	0.000563
Maximum load (kN)	2.168498	2.168498	2.15873	2.15873	2.15873	2.162637	0.00535
Cyclic load (kN)	2.139194	2.139194	2.129426	2.119658	2.119658	2.129426	0.009768
Contact load (kN)	0.029304	0.029304	0.029304	0.039072	0.039072	0.033211	0.00535
Average resilient def. (mm)	0.212332	0.211111	0.209878	0.208657	0.211111	0.210618	0.001398
Axial 1 resilient def. (mm)	0.202686	0.200244	0.200244	0.197802	0.200244	0.200244	0.001727
Axial 2 resilient def. (mm)	0.221978	0.221978	0.219512	0.219512	0.221978	0.220991	0.001351
Actuator resilient def. (mm)	0.32967	0.32967	0.336996	0.32967	0.32967	0.331136	0.003276
Average permanent def. (mm)	0.85232	0.85232	0.853553	0.854774	0.85232	0.853057	0.001098
Axial 1 permanent def. (mm)	0.851258	0.851258	0.851258	0.8537	0.851258	0.851746	0.001092
Axial 2 permanent def. (mm)	0.853382	0.853382	0.855849	0.855849	0.853382	0.854369	0.001351
Actuator permanent def. (mm)	0.879121	0.879121	0.871795	0.879121	0.879121	0.877656	0.003276
Sequence Number	49						
Cycle Number	196	197	198	199	200	Average	Std Dev.
Resilient Modulus (MPa)	213.176459	214.469613	218.458451	218.458451	217.116898	216.335974	2.402369
Resilient micro-strain	1038.477192	1032.215648	1013.368398	1013.368398	1019.629943	1023.411916	11.407411
Confining pressure (kPa)	21.098901	20.21978	19.92674	19.92674	20.21978	20.278388	0.481514
Maximum axial stress (kPa)	226.353697	225.109995	225.109995	225.109995	225.109995	225.358736	0.5562
Cyclic stress (kPa)	221.37889	221.37889	221.37889	221.37889	221.37889	221.37889	0
Contact stress (kPa)	4.974807	3.731105	3.731105	3.731105	3.731105	3.979845	0.5562
Permanent strain (%)	0.430168	0.429536	0.430794	0.430794	0.430168	0.430292	0.000526
Maximum load (kN)	1.777778	1.76801	1.76801	1.76801	1.76801	1.769963	0.004368
Cyclic load (kN)	1.738706	1.738706	1.738706	1.738706	1.738706	1.738706	0
Contact load (kN)	0.039072	0.029304	0.029304	0.029304	0.029304	0.031258	0.004368
Average resilient def. (mm)	0.202503	0.201282	0.197607	0.197607	0.198828	0.199565	0.002224
Axial 1 resilient def. (mm)	0.19536	0.192918	0.188034	0.188034	0.190476	0.190965	0.003184
Axial 2 resilient def. (mm)	0.209646	0.209646	0.207179	0.207179	0.207179	0.208166	0.001351
Actuator resilient def. (mm)	0.322344	0.307692	0.300366	0.307692	0.307692	0.309158	0.008025
Average permanent def. (mm)	0.838828	0.837595	0.840049	0.840049	0.838828	0.83907	0.001026
Axial 1 permanent def. (mm)	0.836606	0.836606	0.839048	0.839048	0.836606	0.837582	0.001338
Axial 2 permanent def. (mm)	0.84105	0.838584	0.84105	0.84105	0.84105	0.840557	0.001103

Actuator permanent def. (mm)	0.857143	0.857143	0.864469	0.864469	0.857143	0.860073	0.004013
Sequence Number	50						
Cycle Number	196	197	198	199	200	Average	Std Dev.
Resilient Modulus (MPa)	278.525361	275.594129	280.021933	282.581955	279.5764	279.259956	2.534479
Resilient micro-strain	1183.306722	1195.892427	1176.982562	1170.721017	1183.306722	1182.04189	9.33804
Confining pressure (kPa)	30.47619	30.47619	30.47619	30.47619	30.18315	30.417582	0.131052
Maximum axial stress (kPa)	334.555739	334.555739	334.555739	335.79944	334.555739	334.804479	0.5562
Cyclic stress (kPa)	329.580932	329.580932	329.580932	330.824634	330.824634	330.078413	0.681203
Contact stress (kPa)	4.974807	4.974807	4.974807	4.974807	3.731105	4.726066	0.5562
Permanent strain (%)	0.441495	0.440237	0.441495	0.441495	0.441495	0.441244	0.000563
Maximum load (kN)	2.627595	2.627595	2.627595	2.637363	2.627595	2.629548	0.004368
Cyclic load (kN)	2.588523	2.588523	2.588523	2.598291	2.598291	2.59243	0.00535
Contact load (kN)	0.039072	0.039072	0.039072	0.039072	0.029304	0.037118	0.004368
Average resilient def. (mm)	0.230745	0.233199	0.229512	0.228291	0.230745	0.230498	0.001821
Axial 1 resilient def. (mm)	0.21978	0.222222	0.21978	0.217338	0.21978	0.21978	0.001727
Axial 2 resilient def. (mm)	0.241709	0.244176	0.239243	0.239243	0.241709	0.241216	0.002064
Actuator resilient def. (mm)	0.373626	0.373626	0.373626	0.373626	0.373626	0.373626	0
Average permanent def. (mm)	0.860916	0.858462	0.860916	0.860916	0.860916	0.860425	0.001098
Axial 1 permanent def. (mm)	0.858584	0.856142	0.858584	0.858584	0.858584	0.858095	0.001092
Axial 2 permanent def. (mm)	0.863248	0.860781	0.863248	0.863248	0.863248	0.862755	0.001103
Actuator permanent def. (mm)	0.886447	0.886447	0.886447	0.886447	0.886447	0.886447	0
Sequence Number	51						
Cycle Number	196	197	198	199	200	Average	Std Dev.
Resilient Modulus (MPa)	336.254063	331.553078	337.840091	335.312174	333.079321	334.807745	2.506078
Resilient micro-strain	1320.434551	1339.15657	1314.235622	1320.434551	1333.020256	1325.45631	10.262192
Confining pressure (kPa)	40.43956	40.43956	40.43956	40.732601	40.14652	40.43956	0.207211
Maximum axial stress (kPa)	450.21999	450.21999	450.21999	448.976289	450.21999	449.97125	0.5562
Cyclic stress (kPa)	444.001482	444.001482	444.001482	442.757781	444.001482	443.752742	0.5562
Contact stress (kPa)	6.218508	6.218508	6.218508	6.218508	6.218508	6.218508	0
Permanent strain (%)	0.457231	0.457231	0.457231	0.457231	0.456598	0.457104	0.000283
Maximum load (kN)	3.53602	3.53602	3.53602	3.526252	3.53602	3.534066	0.004368
Cyclic load (kN)	3.487179	3.487179	3.487179	3.477411	3.487179	3.485226	0.004368
Contact load (kN)	0.04884	0.04884	0.04884	0.04884	0.04884	0.04884	0
Average resilient def. (mm)	0.257485	0.261136	0.256276	0.257485	0.259939	0.258464	0.002001
Axial 1 resilient def. (mm)	0.246545	0.248962	0.244127	0.246545	0.246545	0.246545	0.001709
Axial 2 resilient def. (mm)	0.268425	0.273309	0.268425	0.268425	0.273333	0.270383	0.002682
Actuator resilient def. (mm)	0.432234	0.43956	0.432234	0.432234	0.432234	0.4337	0.003276
Average permanent def. (mm)	0.8916	0.8916	0.8916	0.8916	0.890366	0.891353	0.000552
Axial 1 permanent def. (mm)	0.887888	0.887888	0.887888	0.887888	0.887888	0.887888	0
Axial 2 permanent def. (mm)	0.895311	0.895311	0.895311	0.895311	0.892845	0.894818	0.001103
Actuator permanent def. (mm)	0.915751	0.908425	0.908425	0.908425	0.908425	0.90989	0.003276
Sequence Number	52						
Cycle Number	196	197	198	199	200	Average	Std Dev.
Resilient Modulus (MPa)	362.622384	364.135349	363.440746	361.936979	358.921837	362.211459	2.017319
Resilient micro-strain	1491.938261	1485.739332	1492.000877	1498.199806	1510.785511	1495.732757	9.498229
Confining pressure (kPa)	50.40293	50.40293	50.695971	50.40293	50.10989	50.40293	0.207211
Maximum axial stress (kPa)	548.472419	548.472419	549.716121	549.716121	549.716121	549.21864	0.681203
Cyclic stress (kPa)	541.010209	541.010209	542.253911	542.253911	542.253911	541.75643	0.681203
Contact stress (kPa)	7.46221	7.46221	7.46221	7.46221	7.46221	7.46221	0
Permanent strain (%)	0.487436	0.487436	0.487436	0.487436	0.486178	0.487184	0.000563
Maximum load (kN)	4.307692	4.307692	4.31746	4.31746	4.31746	4.313553	0.00535
Cyclic load (kN)	4.249084	4.249084	4.258852	4.258852	4.258852	4.254945	0.00535
Contact load (kN)	0.058608	0.058608	0.058608	0.058608	0.058608	0.058608	0
Average resilient def. (mm)	0.290928	0.289719	0.29094	0.292149	0.294603	0.291668	0.001852
Axial 1 resilient def. (mm)	0.277387	0.274969	0.274969	0.277387	0.279829	0.276908	0.002031
Axial 2 resilient def. (mm)	0.304469	0.304469	0.306911	0.306911	0.309377	0.306427	0.002052
Actuator resilient def. (mm)	0.490842	0.490842	0.490842	0.490842	0.490842	0.490842	0
Average permanent def. (mm)	0.950501	0.950501	0.950501	0.950501	0.948046	0.95001	0.001098
Axial 1 permanent def. (mm)	0.946496	0.946496	0.946496	0.946496	0.944054	0.946007	0.001092
Axial 2 permanent def. (mm)	0.954505	0.954505	0.954505	0.954505	0.952039	0.954012	0.001103
Actuator permanent def. (mm)	0.967033	0.967033	0.967033	0.967033	0.967033	0.967033	0
Sequence Number	53						
Cycle Number	196	197	198	199	200	Average	Std Dev.
Resilient Modulus (MPa)	213.877654	216.229509	214.957844	216.229509	212.797464	214.818396	1.497589
Resilient micro-strain	1151.372844	1138.849754	1151.372844	1138.849754	1151.372844	1146.363608	6.859179
Confining pressure (kPa)	20.21978	20.512821	20.512821	20.512821	20.21978	20.395604	0.160505
Maximum axial stress (kPa)	251.227729	249.984028	251.227729	249.984028	249.984028	250.481508	0.681203
Cyclic stress (kPa)	246.252923	246.252923	247.496625	246.252923	245.009221	246.252923	0.87943
Contact stress (kPa)	4.974807	3.731105	3.731105	3.731105	4.974807	4.228586	0.681203
Permanent strain (%)	0.462891	0.462265	0.462891	0.462891	0.462265	0.46264	0.000343
Maximum load (kN)	1.973138	1.96337	1.973138	1.96337	1.96337	1.967277	0.00535
Cyclic load (kN)	1.934066	1.934066	1.943834	1.934066	1.924298	1.934066	0.006907
Contact load (kN)	0.039072	0.029304	0.029304	0.029304	0.039072	0.033211	0.00535
Average resilient def. (mm)	0.224518	0.222076	0.224518	0.222076	0.224518	0.223541	0.001338

Axial 1 resilient def. (mm)	0.214896	0.214896	0.214896	0.212454	0.217338	0.214896	0.001727
Axial 2 resilient def. (mm)	0.234139	0.229255	0.234139	0.231697	0.231697	0.232186	0.002043
Actuator resilient def. (mm)	0.344322	0.336996	0.336996	0.32967	0.336996	0.336996	0.00518
Average permanent def. (mm)	0.902637	0.901416	0.902637	0.902637	0.901416	0.902149	0.000669
Axial 1 permanent def. (mm)	0.900098	0.897656	0.900098	0.900098	0.897656	0.899121	0.001338
Axial 2 permanent def. (mm)	0.905177	0.905177	0.905177	0.905177	0.905177	0.905177	0
Actuator permanent def. (mm)	0.930403	0.930403	0.937729	0.937729	0.930403	0.933333	0.004013
Sequence Number	54						
Cycle Number	196	197	198	199	200	Average	Std Dev.
Resilient Modulus (MPa)	277.516745	277.516745	278.841627	277.516745	277.516745	277.781722	0.592505
Resilient micro-strain	1331.016562	1331.016562	1324.692402	1331.016562	1331.016562	1329.75173	2.82825
Confining pressure (kPa)	30.47619	30.47619	30.47619	30.47619	30.47619	30.47619	0
Maximum axial stress (kPa)	375.597893	375.597893	375.597893	375.597893	374.354191	375.349152	0.5562
Cyclic stress (kPa)	369.379384	369.379384	369.379384	369.379384	369.379384	369.379384	0
Contact stress (kPa)	6.218508	6.218508	6.218508	6.218508	4.974807	5.969768	0.5562
Permanent strain (%)	0.476109	0.476109	0.476741	0.476109	0.476109	0.476236	0.000283
Maximum load (kN)	2.949939	2.949939	2.949939	2.949939	2.940171	2.947985	0.004368
Cyclic load (kN)	2.901099	2.901099	2.901099	2.901099	2.901099	2.901099	0
Contact load (kN)	0.04884	0.04884	0.04884	0.04884	0.039072	0.046886	0.004368
Average resilient def. (mm)	0.259548	0.259548	0.258315	0.259548	0.259548	0.259302	0.000552
Axial 1 resilient def. (mm)	0.248596	0.248596	0.248596	0.248596	0.248596	0.248596	0
Axial 2 resilient def. (mm)	0.270501	0.270501	0.268034	0.270501	0.270501	0.270007	0.001103
Actuator resilient def. (mm)	0.40293	0.410256	0.410256	0.410256	0.410256	0.408791	0.003276
Average permanent def. (mm)	0.928413	0.928413	0.929646	0.928413	0.928413	0.928659	0.000552
Axial 1 permanent def. (mm)	0.924518	0.924518	0.924518	0.924518	0.924518	0.924518	0
Axial 2 permanent def. (mm)	0.932308	0.932308	0.934774	0.932308	0.932308	0.932801	0.001103
Actuator permanent def. (mm)	0.959707	0.952381	0.959707	0.952381	0.952381	0.955311	0.004013
Sequence Number	55						
Cycle Number	196	197	198	199	200	Average	Std Dev.
Resilient Modulus (MPa)	331.65646	330.27775	331.111785	333.060832	330.263882	331.274142	1.159549
Resilient micro-strain	1484.987947	1491.186876	1491.186876	1478.726402	1491.249491	1487.467518	5.57956
Confining pressure (kPa)	40.14652	40.43956	40.43956	40.43956	40.43956	40.380952	0.131052
Maximum axial stress (kPa)	499.968056	498.724354	499.968056	498.724354	498.724354	499.221835	0.681203
Cyclic stress (kPa)	492.505846	492.505846	493.749548	492.505846	492.505846	492.754586	0.5562
Contact stress (kPa)	7.46221	6.218508	6.218508	6.218508	6.218508	6.467248	0.5562
Permanent strain (%)	0.494988	0.494988	0.494988	0.494988	0.494361	0.494862	0.00028
Maximum load (kN)	3.92674	3.916972	3.92674	3.916972	3.916972	3.920879	0.00535
Cyclic load (kN)	3.868132	3.868132	3.8779	3.868132	3.868132	3.870085	0.004368
Contact load (kN)	0.058608	0.04884	0.04884	0.04884	0.04884	0.050794	0.004368
Average resilient def. (mm)	0.289573	0.290781	0.290781	0.288352	0.290794	0.290056	0.001088
Axial 1 resilient def. (mm)	0.274823	0.277241	0.277241	0.274823	0.277265	0.276278	0.001329
Axial 2 resilient def. (mm)	0.304322	0.304322	0.304322	0.30188	0.304322	0.303834	0.001092
Actuator resilient def. (mm)	0.47619	0.47619	0.468864	0.483516	0.47619	0.47619	0.00518
Average permanent def. (mm)	0.965226	0.965226	0.965226	0.965226	0.964005	0.964982	0.000546
Axial 1 permanent def. (mm)	0.961148	0.961148	0.961148	0.961148	0.958706	0.960659	0.001092
Axial 2 permanent def. (mm)	0.969304	0.969304	0.969304	0.969304	0.969304	0.969304	0
Actuator permanent def. (mm)	0.981685	0.989011	0.989011	0.981685	0.981685	0.984615	0.004013
Sequence Number	56						
Cycle Number	196	197	198	199	200	Average	Std Dev.
Resilient Modulus (MPa)	232.407862	233.217702	231.266089	231.117815	231.095218	231.820937	0.951885
Resilient micro-strain	1268.275884	1274.537428	1274.537428	1280.736358	1280.861589	1275.789737	5.238971
Confining pressure (kPa)	20.21978	20.512821	20.512821	20.21978	19.92674	20.278388	0.245175
Maximum axial stress (kPa)	299.732093	302.219496	299.732093	300.975795	300.975795	300.727054	1.040555
Cyclic stress (kPa)	294.757287	297.24469	294.757287	296.000988	296.000988	295.752248	1.040555
Contact stress (kPa)	4.974807	4.974807	4.974807	4.974807	4.974807	4.974807	0
Permanent strain (%)	0.479885	0.479885	0.479885	0.479885	0.479252	0.479758	0.000283
Maximum load (kN)	2.35409	2.373626	2.35409	2.363858	2.363858	2.361905	0.008173
Cyclic load (kN)	2.315018	2.334554	2.315018	2.324786	2.324786	2.322833	0.008173
Contact load (kN)	0.039072	0.039072	0.039072	0.039072	0.039072	0.039072	0
Average resilient def. (mm)	0.247314	0.248535	0.248535	0.249744	0.249768	0.248779	0.001022
Axial 1 resilient def. (mm)	0.238852	0.238852	0.238852	0.24127	0.238852	0.239336	0.001081
Axial 2 resilient def. (mm)	0.255775	0.258217	0.258217	0.258217	0.260684	0.258222	0.001735
Actuator resilient def. (mm)	0.373626	0.388278	0.373626	0.380952	0.380952	0.379487	0.006129
Average permanent def. (mm)	0.935775	0.935775	0.935775	0.935775	0.934542	0.935529	0.000552
Axial 1 permanent def. (mm)	0.931844	0.931844	0.931844	0.931844	0.931844	0.931844	0
Axial 2 permanent def. (mm)	0.939707	0.939707	0.939707	0.939707	0.937241	0.939214	0.001103
Actuator permanent def. (mm)	0.967033	0.967033	0.967033	0.967033	0.967033	0.967033	0
Sequence Number	57						
Cycle Number	196	197	198	199	200	Average	Std Dev.
Resilient Modulus (MPa)	302.0144	301.561864	302.862755	302.0144	299.443683	301.57942	1.283262
Resilient micro-strain	1466.015466	1472.339626	1466.015466	1466.015466	1478.601171	1469.797439	5.632015
Confining pressure (kPa)	30.18315	30.47619	30.47619	30.769231	30.47619	30.47619	0.207211
Maximum axial stress (kPa)	448.976289	450.21999	448.976289	448.976289	448.976289	449.225029	0.5562
Cyclic stress (kPa)	442.757781	444.001482	444.001482	442.757781	442.757781	443.255261	0.681203

Contact stress (kPa)	6.218508	6.218508	4.974807	6.218508	6.218508	5.969768	0.5562
Permanent strain (%)	0.496879	0.496246	0.496879	0.496879	0.496246	0.496626	0.000346
Maximum load (kN)	3.526252	3.53602	3.526252	3.526252	3.526252	3.528205	0.004368
Cyclic load (kN)	3.477411	3.487179	3.487179	3.477411	3.477411	3.481319	0.00535
Contact load (kN)	0.04884	0.04884	0.039072	0.04884	0.04884	0.046886	0.004368
Average resilient def. (mm)	0.285873	0.287106	0.285873	0.285873	0.288327	0.286611	0.001098
Axial 1 resilient def. (mm)	0.274799	0.274799	0.274799	0.274799	0.274799	0.274799	0
Axial 2 resilient def. (mm)	0.296947	0.299414	0.296947	0.296947	0.301856	0.298422	0.002196
Actuator resilient def. (mm)	0.454212	0.461538	0.454212	0.454212	0.454212	0.455678	0.003276
Average permanent def. (mm)	0.968913	0.96768	0.968913	0.968913	0.96768	0.96842	0.000675
Axial 1 permanent def. (mm)	0.96359	0.96359	0.96359	0.96359	0.96359	0.96359	0
Axial 2 permanent def. (mm)	0.974237	0.97177	0.974237	0.974237	0.97177	0.97325	0.001351
Actuator permanent def. (mm)	0.996337	0.996337	0.996337	0.996337	0.996337	0.996337	0
Sequence Number	58						
Cycle Number	196	197	198	199	200	Average	Std Dev.
Resilient Modulus (MPa)	333.032985	332.547497	331.586816	330.196515	331.367836	331.74633	1.103175
Resilient micro-strain	1770.138693	1776.462853	1789.111174	1789.111174	1782.787014	1781.522182	8.245696
Confining pressure (kPa)	40.43956	41.025641	40.14652	40.14652	40.43956	40.43956	0.3589
Maximum axial stress (kPa)	598.220485	599.464186	600.707888	598.220485	598.220485	598.966705	1.112401
Cyclic stress (kPa)	589.514573	590.758275	593.245678	590.758275	590.758275	591.007015	1.362407
Contact stress (kPa)	8.705911	8.705911	7.46221	7.46221	7.46221	7.95969	0.681203
Permanent strain (%)	0.56295	0.56295	0.56295	0.56295	0.56295	0.56295	0
Maximum load (kN)	4.698413	4.708181	4.717949	4.698413	4.698413	4.704274	0.008737
Cyclic load (kN)	4.630037	4.639805	4.659341	4.639805	4.639805	4.641758	0.0107
Contact load (kN)	0.068376	0.068376	0.058608	0.058608	0.058608	0.062515	0.00535
Average resilient def. (mm)	0.345177	0.34641	0.348877	0.348877	0.347643	0.347397	0.001608
Axial 1 resilient def. (mm)	0.327766	0.330232	0.332698	0.332698	0.330232	0.330725	0.002064
Axial 2 resilient def. (mm)	0.362589	0.362589	0.365055	0.365055	0.365055	0.364068	0.001351
Actuator resilient def. (mm)	0.556777	0.556777	0.556777	0.571429	0.556777	0.559707	0.006553
Average permanent def. (mm)	1.097753	1.097753	1.097753	1.097753	1.097753	1.097753	0
Axial 1 permanent def. (mm)	1.093016	1.093016	1.093016	1.093016	1.093016	1.093016	0
Axial 2 permanent def. (mm)	1.102491	1.102491	1.102491	1.102491	1.102491	1.102491	0
Actuator permanent def. (mm)	1.120879	1.120879	1.120879	1.113553	1.120879	1.119414	0.003276
Sequence Number	59						
Cycle Number	196	197	198	199	200	Average	Std Dev.
Resilient Modulus (MPa)	292.726632	290.21483	290.542428	290.894	290.19347	290.914272	1.052628
Resilient micro-strain	1682.477067	1701.324317	1695.125387	1688.801227	1701.449548	1693.835509	8.217022
Confining pressure (kPa)	30.47619	30.47619	30.18315	30.18315	31.062271	30.47619	0.3589
Maximum axial stress (kPa)	498.724354	499.968056	498.724354	498.724354	499.968056	499.221835	0.681203
Cyclic stress (kPa)	492.505846	493.749548	492.505846	491.262144	493.749548	492.754586	1.040555
Contact stress (kPa)	6.218508	6.218508	6.218508	7.46221	6.218508	6.467248	0.5562
Permanent strain (%)	0.576776	0.575524	0.576776	0.576776	0.576776	0.576525	0.00056
Maximum load (kN)	3.916972	3.92674	3.916972	3.916972	3.92674	3.920879	0.00535
Cyclic load (kN)	3.868132	3.8779	3.868132	3.858364	3.8779	3.870085	0.008173
Contact load (kN)	0.04884	0.04884	0.04884	0.058608	0.04884	0.050794	0.004368
Average resilient def. (mm)	0.328083	0.331758	0.330549	0.329316	0.331783	0.330298	0.001602
Axial 1 resilient def. (mm)	0.313236	0.318144	0.315702	0.315702	0.318168	0.31619	0.002058
Axial 2 resilient def. (mm)	0.34293	0.345372	0.345397	0.34293	0.345397	0.344405	0.001346
Actuator resilient def. (mm)	0.512821	0.520147	0.512821	0.520147	0.520147	0.517216	0.004013
Average permanent def. (mm)	1.124713	1.122271	1.124713	1.124713	1.124713	1.124225	0.001092
Axial 1 permanent def. (mm)	1.119878	1.117436	1.119878	1.119878	1.119878	1.119389	0.001092
Axial 2 permanent def. (mm)	1.129548	1.127106	1.129548	1.129548	1.129548	1.12906	0.001092
Actuator permanent def. (mm)	1.157509	1.150183	1.157509	1.150183	1.157509	1.154579	0.004013
Sequence Number	60						
Cycle Number	196	197	198	199	200	Average	Std Dev.
Resilient Modulus (MPa)	236.691897	235.671586	234.660034	235.671586	234.833869	235.505794	0.810649
Resilient micro-strain	1460.755768	1467.079929	1473.404089	1467.079929	1467.017313	1467.067406	4.471944
Confining pressure (kPa)	20.21978	20.21978	20.805861	20.21978	20.21978	20.336996	0.262103
Maximum axial stress (kPa)	350.72386	350.72386	350.72386	350.72386	349.480158	350.47512	0.5562
Cyclic stress (kPa)	345.749053	345.749053	345.749053	345.749053	344.505352	345.500313	0.5562
Contact stress (kPa)	4.974807	4.974807	4.974807	4.974807	4.974807	4.974807	0
Permanent strain (%)	0.573019	0.572387	0.572387	0.572387	0.57176	0.572388	0.000445
Maximum load (kN)	2.754579	2.754579	2.754579	2.754579	2.744811	2.752625	0.004368
Cyclic load (kN)	2.715507	2.715507	2.715507	2.715507	2.705739	2.713553	0.004368
Contact load (kN)	0.039072	0.039072	0.039072	0.039072	0.039072	0.039072	0
Average resilient def. (mm)	0.284847	0.286081	0.287314	0.286081	0.286068	0.286078	0.000872
Axial 1 resilient def. (mm)	0.2737	0.2737	0.276166	0.2737	0.276142	0.274681	0.001344
Axial 2 resilient def. (mm)	0.295995	0.298462	0.298462	0.298462	0.295995	0.297475	0.001351
Actuator resilient def. (mm)	0.432234	0.432234	0.424908	0.43956	0.432234	0.432234	0.00518
Average permanent def. (mm)	1.117387	1.116154	1.116154	1.116154	1.114933	1.116156	0.000868
Axial 1 permanent def. (mm)	1.112552	1.112552	1.112552	1.112552	1.11011	1.112063	0.001092
Axial 2 permanent def. (mm)	1.122222	1.119756	1.119756	1.119756	1.119756	1.120249	0.001103
Actuator permanent def. (mm)	1.150183	1.142857	1.150183	1.142857	1.142857	1.145788	0.004013
Sequence Number	61						

Appendix C: Red Sand Stabilisation

Cycle Number	196	197	198	199	200	Average	Std Dev.
Resilient Modulus (MPa)	297.492156	300.947529	301.314858	299.207104	299.207104	299.63375	1.541316
Resilient micro-strain	1826.930904	1801.82211	1795.497949	1808.14627	1808.14627	1808.1087	11.756173
Confining pressure (kPa)	30.47619	30.47619	30.47619	30.47619	30.18315	30.417582	0.131052
Maximum axial stress (kPa)	549.716121	548.472419	548.472419	548.472419	548.472419	548.72116	0.5562
Cyclic stress (kPa)	543.497613	542.253911	541.010209	541.010209	541.010209	541.75643	1.112401
Contact stress (kPa)	6.218508	6.218508	7.46221	7.46221	7.46221	6.964729	0.681203
Permanent strain (%)	0.612924	0.61417	0.61417	0.61417	0.61417	0.613921	0.000557
Maximum load (kN)	4.31746	4.307692	4.307692	4.307692	4.307692	4.309646	0.004368
Cyclic load (kN)	4.26862	4.258852	4.249084	4.249084	4.249084	4.254945	0.008737
Contact load (kN)	0.04884	0.04884	0.058608	0.058608	0.058608	0.054701	0.00535
Average resilient def. (mm)	0.356252	0.351355	0.350122	0.352589	0.352589	0.352581	0.002292
Axial 1 resilient def. (mm)	0.341734	0.33685	0.334383	0.33685	0.33685	0.337333	0.002682
Axial 2 resilient def. (mm)	0.370769	0.365861	0.365861	0.368327	0.368327	0.367829	0.002055
Actuator resilient def. (mm)	0.564103	0.549451	0.549451	0.549451	0.556777	0.553846	0.006553
Average permanent def. (mm)	1.195201	1.197631	1.197631	1.197631	1.197631	1.197145	0.001087
Axial 1 permanent def. (mm)	1.190037	1.192454	1.192454	1.192454	1.192454	1.191971	0.001081
Axial 2 permanent def. (mm)	1.200366	1.202808	1.202808	1.202808	1.202808	1.20232	0.001092
Actuator permanent def. (mm)	1.216117	1.223443	1.223443	1.223443	1.216117	1.220513	0.004013
Sequence Number	62						
Cycle Number	196	197	198	199	200	Average	Std Dev.
Resilient Modulus (MPa)	236.62001	238.543205	239.521436	239.346381	238.37284	238.480774	1.152198
Resilient micro-strain	1561.065715	1548.48001	1542.15585	1548.48001	1554.80417	1550.997151	7.188706
Confining pressure (kPa)	20.21978	20.21978	20.512821	20.805861	20.21978	20.395604	0.262103
Maximum axial stress (kPa)	374.354191	374.354191	374.354191	375.597893	375.597893	374.851672	0.681203
Cyclic stress (kPa)	369.379384	369.379384	369.379384	370.623086	370.623086	369.876865	0.681203
Contact stress (kPa)	4.974807	4.974807	4.974807	4.974807	4.974807	4.974807	0
Permanent strain (%)	0.611052	0.611678	0.611678	0.611678	0.611678	0.611553	0.00028
Maximum load (kN)	2.940171	2.940171	2.940171	2.949939	2.949939	2.944078	0.00535
Cyclic load (kN)	2.901099	2.901099	2.901099	2.910867	2.910867	2.905006	0.00535
Contact load (kN)	0.039072	0.039072	0.039072	0.039072	0.039072	0.039072	0
Average resilient def. (mm)	0.304408	0.301954	0.30072	0.301954	0.303187	0.302444	0.001402
Axial 1 resilient def. (mm)	0.292357	0.28989	0.28989	0.28989	0.292357	0.290877	0.001351
Axial 2 resilient def. (mm)	0.316459	0.314017	0.311551	0.314017	0.314017	0.314012	0.001735
Actuator resilient def. (mm)	0.454212	0.446886	0.454212	0.454212	0.454212	0.452747	0.003276
Average permanent def. (mm)	1.191551	1.192772	1.192772	1.192772	1.192772	1.192527	0.000546
Axial 1 permanent def. (mm)	1.187619	1.187619	1.187619	1.187619	1.187619	1.187619	0
Axial 2 permanent def. (mm)	1.195482	1.197924	1.197924	1.197924	1.197924	1.197436	0.001092
Actuator permanent def. (mm)	1.223443	1.230769	1.223443	1.230769	1.230769	1.227839	0.004013
Sequence Number	63						
Cycle Number	196	197	198	199	200	Average	Std Dev.
Resilient Modulus (MPa)	300.157903	298.862167	300.157903	296.620461	296.601077	298.479902	1.786407
Resilient micro-strain	1885.288501	1897.623744	1885.288501	1916.157916	1916.283147	1900.128362	15.529325
Confining pressure (kPa)	29.59707	30.47619	30.47619	30.18315	30.47619	30.241758	0.382078
Maximum axial stress (kPa)	573.346452	574.590154	573.346452	575.833855	575.833855	574.590154	1.243702
Cyclic stress (kPa)	565.884242	567.127944	565.884242	568.371645	568.371645	567.127944	1.243702
Contact stress (kPa)	7.46221	7.46221	7.46221	7.46221	7.46221	7.46221	0
Permanent strain (%)	0.66775	0.66775	0.66775	0.66775	0.666504	0.667501	0.000557
Maximum load (kN)	4.503053	4.512821	4.503053	4.522589	4.522589	4.512821	0.009768
Cyclic load (kN)	4.444444	4.454212	4.444444	4.46398	4.46398	4.454212	0.009768
Contact load (kN)	0.058608	0.058608	0.058608	0.058608	0.058608	0.058608	0
Average resilient def. (mm)	0.367631	0.370037	0.367631	0.373651	0.373675	0.370525	0.003028
Axial 1 resilient def. (mm)	0.35265	0.355043	0.35265	0.357436	0.35746	0.355048	0.002399
Axial 2 resilient def. (mm)	0.382613	0.385031	0.382613	0.389866	0.38989	0.386002	0.003673
Actuator resilient def. (mm)	0.578755	0.578755	0.571429	0.578755	0.586081	0.578755	0.00518
Average permanent def. (mm)	1.302112	1.302112	1.302112	1.302112	1.299683	1.301626	0.001087
Axial 1 permanent def. (mm)	1.29641	1.29641	1.29641	1.29641	1.293993	1.295927	0.001081
Axial 2 permanent def. (mm)	1.307814	1.307814	1.307814	1.307814	1.305372	1.307326	0.001092
Actuator permanent def. (mm)	1.326007	1.326007	1.326007	1.333333	1.326007	1.327473	0.003276
Sequence Number	64						
Cycle Number	196	197	198	199	200	Average	Std Dev.
Resilient Modulus (MPa)	239.799832	240.707401	243.336546	240.878139	240.707401	241.085864	1.327504
Resilient micro-strain	1644.093798	1637.894869	1625.309164	1631.570708	1637.894869	1635.352682	7.150317
Confining pressure (kPa)	20.512821	20.512821	20.512821	20.21978	20.512821	20.454212	0.131052
Maximum axial stress (kPa)	399.228224	399.228224	400.471925	399.228224	399.228224	399.476964	0.5562
Cyclic stress (kPa)	394.253417	394.253417	395.497119	393.009715	394.253417	394.253417	0.87943
Contact stress (kPa)	4.974807	4.974807	4.974807	6.218508	4.974807	5.223547	0.5562
Permanent strain (%)	0.66775	0.66837	0.668996	0.66837	0.66837	0.668371	0.000441
Maximum load (kN)	3.135531	3.135531	3.145299	3.135531	3.135531	3.137485	0.004368
Cyclic load (kN)	3.096459	3.096459	3.106227	3.086691	3.096459	3.096459	0.006907
Contact load (kN)	0.039072	0.039072	0.039072	0.04884	0.039072	0.041026	0.004368
Average resilient def. (mm)	0.320598	0.319389	0.316935	0.318156	0.319389	0.318894	0.001394
Axial 1 resilient def. (mm)	0.309353	0.306935	0.304469	0.304469	0.306935	0.306432	0.002046
Axial 2 resilient def. (mm)	0.331844	0.331844	0.329402	0.331844	0.331844	0.331355	0.001092
Actuator resilient def. (mm)	0.483516	0.47619	0.468864	0.47619	0.483516	0.477656	0.006129

Average permanent def. (mm)	1.302112	1.303321	1.304542	1.303321	1.303321	1.303324	0.000859
Axial 1 permanent def. (mm)	1.29641	1.298828	1.298828	1.298828	1.298828	1.298344	0.001081
Axial 2 permanent def. (mm)	1.307814	1.307814	1.310256	1.307814	1.307814	1.308303	0.001092
Actuator permanent def. (mm)	1.326007	1.326007	1.333333	1.326007	1.326007	1.327473	0.003276
Sequence Number	65						
Cycle Number	196	197	198	199	200	Average	Std Dev.
Resilient Modulus (MPa)	269.384639	267.105916	269.608714	268.937102	269.608714	268.929017	1.055382
Resilient micro-strain	1832.879371	1839.203532	1826.743058	1826.680442	1826.743058	1830.449892	5.572669
Confining pressure (kPa)	20.21978	20.512821	19.6337	20.21978	20.21978	20.161172	0.32101
Maximum axial stress (kPa)	499.968056	498.724354	498.724354	498.724354	499.968056	499.221835	0.681203
Cyclic stress (kPa)	493.749548	491.262144	492.505846	491.262144	492.505846	492.257106	1.040555
Contact stress (kPa)	6.218508	7.46221	6.218508	7.46221	7.46221	6.964729	0.681203
Permanent strain (%)	0.697655	0.696409	0.697655	0.697655	0.697655	0.697406	0.000557
Maximum load (kN)	3.92674	3.916972	3.916972	3.916972	3.92674	3.920879	0.00535
Cyclic load (kN)	3.8779	3.858364	3.868132	3.858364	3.868132	3.866178	0.008173
Contact load (kN)	0.04884	0.058608	0.04884	0.058608	0.058608	0.054701	0.00535
Average resilient def. (mm)	0.357411	0.358645	0.356215	0.356203	0.356215	0.356938	0.001087
Axial 1 resilient def. (mm)	0.344884	0.344908	0.342491	0.344884	0.342491	0.343932	0.001315
Axial 2 resilient def. (mm)	0.369939	0.372381	0.369939	0.367521	0.369939	0.369944	0.001718
Actuator resilient def. (mm)	0.542125	0.549451	0.534799	0.534799	0.534799	0.539194	0.006553
Average permanent def. (mm)	1.360427	1.357998	1.360427	1.360427	1.360427	1.359941	0.001087
Axial 1 permanent def. (mm)	1.354432	1.352015	1.354432	1.354432	1.354432	1.353949	0.001081
Axial 2 permanent def. (mm)	1.366422	1.36398	1.366422	1.366422	1.366422	1.365934	0.001092
Actuator permanent def. (mm)	1.399267	1.391941	1.399267	1.399267	1.399267	1.397802	0.003276

APPENDIX C-11

PERMANENT DEFORMATION TEST

Appendix C: Red Sand Stabilisation

Stabilised red sand

IPC Global Universal Testing Machine UTM_41 V2.03b Resilient Modulus Test

Filename	D:\my research\Lab test Data\Resilient Modulus\Permanent deformation\						
Operator	Peerapong Jitsangiam						
Test method	Non Standard Testing						
Notes/Comments	ths test follows the standard of Ausroads (APRG 00/33(MA)) for a permanent deformation						
Specimen Information							
********************							
Identification	RSFALKD-200mm						
Core/Sample Number	1						
Dimensions	Point 1	Point 2	Point 3	Point 4	Point 5	Average	Std Dev.
Diameter (mm)	100					100	
Height (mm)	200					200	
Cross-Sectional area	7853.982						
Volume	1570796						
Comments/Properties	The controled materials "crushed rock added with 2% GP cement						
Setup Parameters							
****************							
Dynamic loading options							
Wave shape	Square pulse						
Load duration (msec)	1000						
Cycle duration (msec)	3000						
Contact stress [% of max. stress]	1						
Conditioning Cycles	500						
Cycles per test sequence	500						
Shear test options							
Confining pressure (kPa)	34.5						
Strain rate (%/min)	1						
Gauge length (mm)	200						
Test termination strain (%)							

Sequence #	Confining Pressure (kPa)	Maximum Stress (kPa)
0	50	350
1	50	350
2	50	350
3	50	350
4	50	350
5	50	350
6	50	350
7	50	350
8	50	350
9	50	350
10	50	350
11	50	350
12	50	350
13	50	350
14	50	350
15	50	350
16	50	350
17	50	350
18	50	350
19	50	350
20	50	450
21	50	450
22	50	450
23	50	450
24	50	450
25	50	450
26	50	450
27	50	450
28	50	450
29	50	450
30	50	450
31	50	450
32	50	450
33	50	450
34	50	450

35	50	450						
36	50	450						
37	50	450						
38	50	450						
39	50	450						
40	50	550						
41	50	550						
42	50	550						
43	50	550						
44	50	550						
45	50	550						
46	50	550						
47	50	550						
48	50	550						
49	50	550						
50	50	550						
51	50	550						
52	50	550						
53	50	550						
54	50	550						
55	50	550						
56	50	550						
57	50	550						
58	50	550						
59	50	550						
Calibration Information								
***********************								
Channel description	Filename	Transducer description	Span	Units	Date	Linearised		
A: Axial Force	Y12346.CAR	STC5000 S/N: Y12346 +/-20kN	40	kN	7/12/2005	No		
B: Actuator LVDT	941C-340.CAR	AC-15 S/N: M992941C-340 +/-15mm	30	mm	7/12/2005	No		
C: Axial LVDT #1	83047.car	D6-05000A S/N: 83047 +/-5mm	10	mm	20/12/2005	Yes		
D: Axial LVDT #2	83048.car	D6-05000A S/N: 83048 +/-5mm	10	mm	20/12/2005	Yes		
E: Confining Pressure	S054042.CAR	Pressure S/N: S054042 +/-600kPa	1200	kPa	22/02/2006	No		
Test Results								
************								
Start date and time	Thursday	November 2	2006	at 12:07 PM				
Sequence Number	0							
Cycle Number	496	497	498	499	500	Average	Std Dev.	
Resilient Modulus (MPa)	278.640566	276.265429	274.94629	281.797636	274.9195	277.313884	2.928393	
Resilient micro-strain	1240.842491	1247.008547	1252.991453	1222.527473	1253.113553	1243.296703	12.664128	
Confining pressure (kPa)	50.695971	50.40293	50.40293	50.40293	50.40293	50.461538	0.131052	
Maximum axial stress (kPa)	350.72386	349.480158	349.480158	349.480158	349.480158	349.728899	0.5562	
Cyclic stress (kPa)	345.749053	344.505352	344.505352	344.505352	344.505352	344.754092	0.5562	
Contact stress (kPa)	4.974807	4.974807	4.974807	4.974807	4.974807	4.974807	0	
Permanent strain (%)	0.462503	0.462503	0.461893	0.463114	0.461893	0.462381	0.000511	
Maximum load (kN)	2.754579	2.744811	2.744811	2.744811	2.744811	2.746764	0.004368	
Cyclic load (kN)	2.715507	2.705739	2.705739	2.705739	2.705739	2.707692	0.004368	
Contact load (kN)	0.039072	0.039072	0.039072	0.039072	0.039072	0.039072	0	
Average resilient def. (mm)	0.248168	0.249402	0.250598	0.244505	0.250623	0.248659	0.002533	
Axial 1 resilient def. (mm)	0.239976	0.239976	0.244835	0.237558	0.242418	0.240952	0.002768	
Axial 2 resilient def. (mm)	0.256361	0.258828	0.256361	0.251453	0.258828	0.256366	0.003011	
Actuator resilient def. (mm)	0.3663	0.373626	0.373626	0.3663	0.373626	0.370696	0.004013	
Average permanent def. (mm)	0.925006	0.925006	0.923785	0.926227	0.923785	0.924762	0.001022	
Axial 1 permanent def. (mm)	0.920684	0.920684	0.918242	0.920684	0.918242	0.919707	0.001338	
Axial 2 permanent def. (mm)	0.929328	0.929328	0.929328	0.93177	0.929328	0.929817	0.001092	
Actuator permanent def. (mm)	0.945055	0.937729	0.945055	0.945055	0.937729	0.942125	0.004013	
Sequence Number	1							
Cycle Number	496	497	498	499	500	Average	Std Dev.	
Resilient Modulus (MPa)	283.624732	287.981509	285.470442	286.91258	281.173467	285.032546	2.706339	
Resilient micro-strain	1214.652015	1196.275946	1202.442002	1196.398046	1220.818071	1206.117216	11.110558	
Confining pressure (kPa)	50.40293	50.695971	50.40293	50.40293	50.40293	50.461538	0.131052	
Maximum axial stress (kPa)	349.480158	350.72386	350.72386	349.480158	349.480158	349.977639	0.681203	
Cyclic stress (kPa)	344.505352	344.505352	343.26165	343.26165	343.26165	343.759131	0.681203	
Contact stress (kPa)	4.974807	6.218508	7.46221	6.218508	6.218508	6.218508	0.87943	
Permanent strain (%)	0.485788	0.487625	0.486398	0.486398	0.485171	0.486276	0.00091	
Maximum load (kN)	2.744811	2.754579	2.754579	2.744811	2.744811	2.748718	0.00535	
Cyclic load (kN)	2.705739	2.705739	2.695971	2.695971	2.695971	2.699878	0.00535	
Contact load (kN)	0.039072	0.04884	0.058608	0.04884	0.04884	0.04884	0.006907	
Average resilient def. (mm)	0.24293	0.239255	0.240488	0.23928	0.244164	0.241223	0.002222	
Axial 1 resilient def. (mm)	0.237118	0.232234	0.234676	0.232259	0.237118	0.234681	0.002436	
Axial 2 resilient def. (mm)	0.248742	0.246276	0.2463	0.2463	0.251209	0.247766	0.002198	
Actuator resilient def. (mm)	0.3663	0.358974	0.358974	0.358974	0.358974	0.36044	0.003276	
Average permanent def. (mm)	0.971575	0.97525	0.972796	0.972796	0.970342	0.972552	0.001819	
Axial 1 permanent def. (mm)	0.96464	0.969524	0.967082	0.967082	0.96464	0.966593	0.002043	
Axial 2 permanent def. (mm)	0.97851	0.980977	0.97851	0.97851	0.976044	0.97851	0.001744	
Actuator permanent def. (mm)	0.989011	0.996337	0.989011	0.989011	0.989011	0.990476	0.003276	
Sequence Number	2							

Cycle Number	496	497	498	499	500	Average	Std Dev.
Resilient Modulus (MPa)	290.712463	291.146304	287.77284	289.666735	289.227797	289.705228	1.328041
Resilient micro-strain	1189.316239	1183.272283	1201.465201	1189.316239	1195.421245	1191.758242	6.920638
Confining pressure (kPa)	50.40293	50.40293	50.40293	50.40293	50.10989	50.344322	0.131052
Maximum axial stress (kPa)	351.967562	349.480158	350.72386	349.480158	350.72386	350.47512	1.040555
Cyclic stress (kPa)	345.749053	344.505352	345.749053	344.505352	345.749053	345.251573	0.681203
Contact stress (kPa)	6.218508	4.974807	4.974807	4.974807	4.974807	5.223547	0.5562
Permanent strain (%)	0.49743	0.49743	0.49743	0.49743	0.49743	0.49743	0
Maximum load (kN)	2.764347	2.744811	2.754579	2.744811	2.754579	2.752625	0.008173
Cyclic load (kN)	2.715507	2.705739	2.715507	2.705739	2.715507	2.7116	0.00535
Contact load (kN)	0.04884	0.039072	0.039072	0.039072	0.039072	0.041026	0.004368
Average resilient def. (mm)	0.237863	0.236654	0.240293	0.237863	0.239084	0.238352	0.001384
Axial 1 resilient def. (mm)	0.232088	0.22967	0.234505	0.232088	0.232088	0.232088	0.001709
Axial 2 resilient def. (mm)	0.243639	0.243639	0.246081	0.243639	0.246081	0.244615	0.001338
Actuator resilient def. (mm)	0.3663	0.351648	0.373626	0.3663	0.3663	0.364835	0.008025
Average permanent def. (mm)	0.99486	0.99486	0.99486	0.99486	0.99486	0.99486	0
Axial 1 permanent def. (mm)	0.989011	0.989011	0.989011	0.989011	0.989011	0.989011	0
Axial 2 permanent def. (mm)	1.000708	1.000708	1.000708	1.000708	1.000708	1.000708	0
Actuator permanent def. (mm)	1.010989	1.018315	1.010989	1.010989	1.010989	1.012454	0.003276
Sequence Number	3						
Cycle Number	496	497	498	499	500	Average	Std Dev.
Resilient Modulus (MPa)	292.762525	297.359839	296.286338	297.359839	289.13367	294.580442	3.582329
Resilient micro-strain	1176.739927	1158.547009	1158.547009	1158.547009	1182.905983	1167.057387	11.855475
Confining pressure (kPa)	50.695971	50.40293	50.40293	50.40293	50.40293	50.461538	0.131052
Maximum axial stress (kPa)	349.480158	349.480158	349.480158	349.480158	348.236457	349.231418	0.5562
Cyclic stress (kPa)	344.505352	344.505352	343.26165	344.505352	342.017949	343.759131	1.112401
Contact stress (kPa)	4.974807	4.974807	6.218508	4.974807	6.218508	5.472287	0.681203
Permanent strain (%)	0.505372	0.505977	0.505977	0.505977	0.504756	0.505612	0.000545
Maximum load (kN)	2.744811	2.744811	2.744811	2.744811	2.735043	2.742857	0.004368
Cyclic load (kN)	2.705739	2.705739	2.695971	2.705739	2.686203	2.699878	0.008737
Contact load (kN)	0.039072	0.039072	0.04884	0.039072	0.04884	0.042979	0.00535
Average resilient def. (mm)	0.235348	0.231709	0.231709	0.231709	0.236581	0.233411	0.002371
Axial 1 resilient def. (mm)	0.22967	0.224835	0.224835	0.224835	0.22967	0.226769	0.002648
Axial 2 resilient def. (mm)	0.241026	0.238584	0.238584	0.238584	0.243492	0.240054	0.002194
Actuator resilient def. (mm)	0.358974	0.351648	0.351648	0.344322	0.358974	0.353114	0.006129
Average permanent def. (mm)	1.010745	1.011954	1.011954	1.011954	1.009512	1.011223	0.001091
Axial 1 permanent def. (mm)	1.003516	1.005934	1.005934	1.005934	1.003516	1.004967	0.001324
Axial 2 permanent def. (mm)	1.017973	1.017973	1.017973	1.017973	1.015507	1.01748	0.001103
Actuator permanent def. (mm)	1.032967	1.040293	1.032967	1.040293	1.032967	1.035897	0.004013
Sequence Number	4						
Cycle Number	496	497	498	499	500	Average	Std Dev.
Resilient Modulus (MPa)	300.093763	303.291892	302.200914	298.030587	299.014289	300.526289	2.188303
Resilient micro-strain	1152.136752	1139.98779	1139.98779	1164.285714	1152.136752	1149.70696	10.164551
Confining pressure (kPa)	49.81685	50.40293	50.40293	50.695971	50.40293	50.344322	0.32101
Maximum axial stress (kPa)	350.72386	350.72386	349.480158	351.967562	349.480158	350.47512	1.040555
Cyclic stress (kPa)	345.749053	345.749053	344.505352	346.992755	344.505352	345.500313	1.040555
Contact stress (kPa)	4.974807	4.974807	4.974807	4.974807	4.974807	4.974807	0
Permanent strain (%)	0.512082	0.512082	0.512082	0.512082	0.512082	0.512082	0
Maximum load (kN)	2.754579	2.754579	2.744811	2.764347	2.744811	2.752625	0.008173
Cyclic load (kN)	2.715507	2.715507	2.705739	2.725275	2.705739	2.713553	0.008173
Contact load (kN)	0.039072	0.039072	0.039072	0.039072	0.039072	0.039072	0
Average resilient def. (mm)	0.230427	0.227998	0.227998	0.232857	0.230427	0.229941	0.002033
Axial 1 resilient def. (mm)	0.224835	0.222418	0.222418	0.227253	0.224835	0.224352	0.002023
Axial 2 resilient def. (mm)	0.23602	0.233578	0.233578	0.238462	0.23602	0.235531	0.002043
Actuator resilient def. (mm)	0.358974	0.351648	0.344322	0.358974	0.351648	0.353114	0.006129
Average permanent def. (mm)	1.024164	1.024164	1.024164	1.024164	1.024164	1.024164	0
Axial 1 permanent def. (mm)	1.018022	1.018022	1.018022	1.018022	1.018022	1.018022	0
Axial 2 permanent def. (mm)	1.030305	1.030305	1.030305	1.030305	1.030305	1.030305	0
Actuator permanent def. (mm)	1.040293	1.040293	1.040293	1.047619	1.040293	1.041758	0.003276
Sequence Number	5						
Cycle Number	496	497	498	499	500	Average	Std Dev.
Resilient Modulus (MPa)	306.641913	306.641913	308.866867	309.98191	303.877095	307.20194	2.354892
Resilient micro-strain	1127.533578	1127.533578	1115.384615	1115.384615	1133.699634	1123.907204	8.177131
Confining pressure (kPa)	50.10989	50.40293	50.40293	50.40293	50.10989	50.285714	0.160505
Maximum axial stress (kPa)	350.72386	350.72386	349.480158	350.72386	349.480158	350.226379	0.681203
Cyclic stress (kPa)	345.749053	345.749053	344.505352	345.749053	344.505352	345.251573	0.681203
Contact stress (kPa)	4.974807	4.974807	4.974807	4.974807	4.974807	4.974807	0
Permanent strain (%)	0.518187	0.518187	0.518187	0.518187	0.516966	0.517943	0.000546
Maximum load (kN)	2.754579	2.754579	2.744811	2.754579	2.744811	2.750672	0.00535
Cyclic load (kN)	2.715507	2.715507	2.705739	2.715507	2.705739	2.7116	0.00535
Contact load (kN)	0.039072	0.039072	0.039072	0.039072	0.039072	0.039072	0
Average resilient def. (mm)	0.225507	0.225507	0.223077	0.223077	0.22674	0.224781	0.001635
Axial 1 resilient def. (mm)	0.22	0.22	0.217582	0.217582	0.22	0.219033	0.001324
Axial 2 resilient def. (mm)	0.231013	0.231013	0.228571	0.228571	0.23348	0.23053	0.002052
Actuator resilient def. (mm)	0.351648	0.344322	0.344322	0.344322	0.344322	0.345788	0.003276
Average permanent def. (mm)	1.036374	1.036374	1.036374	1.036374	1.033932	1.035885	0.001092
Axial 1 permanent def. (mm)	1.03011	1.03011	1.03011	1.03011	1.027692	1.029626	0.001081
Axial 2 permanent def. (mm)	1.042637	1.042637	1.042637	1.042637	1.040171	1.042144	0.001103

Appendix C: Red Sand Stabilisation

Actuator permanent def. (mm)	1.054945	1.054945	1.054945	1.054945	1.054945	1.054945	0
Sequence Number	6						
Cycle Number	496	497	498	499	500	Average	Std Dev.
Resilient Modulus (MPa)	308.34483	306.137096	308.917593	302.314243	310.032818	307.149316	3.052587
Resilient micro-strain	1121.306471	1133.455433	1115.201465	1139.56044	1115.201465	1124.945055	11.058372
Confining pressure (kPa)	50.40293	50.40293	50.40293	50.10989	50.40293	50.344322	0.131052
Maximum axial stress (kPa)	350.72386	351.967562	349.480158	349.480158	349.480158	350.226379	1.112401
Cyclic stress (kPa)	345.749053	346.992755	344.505352	344.505352	345.749053	345.500313	1.040555
Contact stress (kPa)	4.974807	4.974807	4.974807	4.974807	3.731105	4.726066	0.5562
Permanent strain (%)	0.52185	0.52185	0.52185	0.520629	0.52185	0.521606	0.000546
Maximum load (kN)	2.754579	2.764347	2.744811	2.744811	2.744811	2.750672	0.008737
Cyclic load (kN)	2.715507	2.725275	2.705739	2.705739	2.715507	2.713553	0.008173
Contact load (kN)	0.039072	0.039072	0.039072	0.039072	0.029304	0.037118	0.004368
Average resilient def. (mm)	0.224261	0.226691	0.22304	0.227912	0.22304	0.224989	0.002212
Axial 1 resilient def. (mm)	0.217582	0.22	0.217582	0.222418	0.217582	0.219033	0.002162
Axial 2 resilient def. (mm)	0.23094	0.233382	0.228498	0.233407	0.228498	0.230945	0.002448
Actuator resilient def. (mm)	0.344322	0.358974	0.344322	0.351648	0.344322	0.348718	0.006553
Average permanent def. (mm)	1.0437	1.0437	1.0437	1.041258	1.0437	1.043211	0.001092
Axial 1 permanent def. (mm)	1.037363	1.037363	1.037363	1.034945	1.037363	1.036879	0.001081
Axial 2 permanent def. (mm)	1.050037	1.050037	1.050037	1.04757	1.050037	1.049543	0.001103
Actuator permanent def. (mm)	1.069597	1.062271	1.062271	1.062271	1.062271	1.063736	0.003276
Sequence Number	7						
Cycle Number	496	497	498	499	500	Average	Std Dev.
Resilient Modulus (MPa)	310.083744	311.244164	312.371861	305.605072	308.411997	309.543368	2.644582
Resilient micro-strain	1115.018315	1102.869353	1102.869353	1127.289377	1121.062271	1113.821734	10.898898
Confining pressure (kPa)	50.40293	50.40293	50.40293	50.40293	50.40293	50.40293	0
Maximum axial stress (kPa)	350.72386	348.236457	349.480158	350.72386	350.72386	349.977639	1.112401
Cyclic stress (kPa)	345.749053	343.26165	344.505352	344.505352	345.749053	344.754092	1.040555
Contact stress (kPa)	4.974807	4.974807	4.974807	6.218508	4.974807	5.223547	0.5562
Permanent strain (%)	0.525513	0.525513	0.525513	0.524896	0.524908	0.525269	0.000334
Maximum load (kN)	2.754579	2.735043	2.744811	2.754579	2.754579	2.748718	0.008737
Cyclic load (kN)	2.715507	2.695971	2.705739	2.705739	2.715507	2.707692	0.008173
Contact load (kN)	0.039072	0.039072	0.039072	0.04884	0.039072	0.041026	0.004368
Average resilient def. (mm)	0.223004	0.220574	0.220574	0.225458	0.224212	0.222764	0.00218
Axial 1 resilient def. (mm)	0.217582	0.215165	0.215165	0.217582	0.22	0.217099	0.002023
Axial 2 resilient def. (mm)	0.228425	0.225983	0.225983	0.233333	0.228425	0.22843	0.003001
Actuator resilient def. (mm)	0.351648	0.32967	0.336996	0.351648	0.344322	0.342857	0.009552
Average permanent def. (mm)	1.051026	1.051026	1.051026	1.049792	1.049817	1.050537	0.000669
Axial 1 permanent def. (mm)	1.044615	1.044615	1.044615	1.044615	1.042198	1.044132	0.001081
Axial 2 permanent def. (mm)	1.057436	1.057436	1.057436	1.054969	1.057436	1.056943	0.001103
Actuator permanent def. (mm)	1.076923	1.084249	1.084249	1.076923	1.076923	1.079853	0.004013
Sequence Number	8						
Cycle Number	496	497	498	499	500	Average	Std Dev.
Resilient Modulus (MPa)	315.904252	315.904252	319.463183	315.904252	317.664809	316.96815	1.589509
Resilient micro-strain	1090.537241	1090.537241	1078.388278	1090.537241	1084.493284	1086.898657	5.429784
Confining pressure (kPa)	50.40293	50.10989	50.40293	50.695971	50.40293	50.40293	0.207211
Maximum axial stress (kPa)	349.480158	349.480158	349.480158	349.480158	349.480158	349.480158	0
Cyclic stress (kPa)	344.505352	344.505352	344.505352	344.505352	344.505352	344.505352	0
Contact stress (kPa)	4.974807	4.974807	4.974807	4.974807	4.974807	4.974807	0
Permanent strain (%)	0.529176	0.529176	0.529176	0.529176	0.529176	0.529176	0
Maximum load (kN)	2.744811	2.744811	2.744811	2.744811	2.744811	2.744811	0
Cyclic load (kN)	2.705739	2.705739	2.705739	2.705739	2.705739	2.705739	0
Contact load (kN)	0.039072	0.039072	0.039072	0.039072	0.039072	0.039072	0
Average resilient def. (mm)	0.218107	0.218107	0.215678	0.218107	0.216899	0.21738	0.001086
Axial 1 resilient def. (mm)	0.212747	0.212747	0.21033	0.212747	0.21033	0.21178	0.001324
Axial 2 resilient def. (mm)	0.223468	0.223468	0.221026	0.223468	0.223468	0.222979	0.001092
Actuator resilient def. (mm)	0.336996	0.336996	0.336996	0.344322	0.336996	0.338462	0.003276
Average permanent def. (mm)	1.058352	1.058352	1.058352	1.058352	1.058352	1.058352	0
Axial 1 permanent def. (mm)	1.051868	1.051868	1.051868	1.051868	1.051868	1.051868	0
Axial 2 permanent def. (mm)	1.064835	1.064835	1.064835	1.064835	1.064835	1.064835	0
Actuator permanent def. (mm)	1.076923	1.076923	1.076923	1.076923	1.076923	1.076923	0
Sequence Number	9						
Cycle Number	496	497	498	499	500	Average	Std Dev.
Resilient Modulus (MPa)	318.345931	315.314821	317.718465	318.847511	319.499358	317.945217	1.609384
Resilient micro-strain	1078.266178	1096.520147	1084.310134	1084.371184	1078.266178	1084.346764	7.452185
Confining pressure (kPa)	50.40293	50.40293	50.695971	50.40293	50.40293	50.461538	0.131052
Maximum axial stress (kPa)	349.480158	350.72386	349.480158	350.72386	349.480158	349.977639	0.681203
Cyclic stress (kPa)	343.26165	345.749053	344.505352	345.749053	344.505352	344.754092	1.040555
Contact stress (kPa)	6.218508	4.974807	4.974807	4.974807	4.974807	5.223547	0.5562
Permanent strain (%)	0.531618	0.531618	0.531618	0.531618	0.531618	0.531618	0
Maximum load (kN)	2.744811	2.754579	2.744811	2.754579	2.744811	2.748718	0.00535
Cyclic load (kN)	2.695971	2.715507	2.705739	2.715507	2.705739	2.707692	0.008173
Contact load (kN)	0.04884	0.039072	0.039072	0.039072	0.039072	0.041026	0.004368
Average resilient def. (mm)	0.215653	0.219304	0.216862	0.216874	0.215653	0.216869	0.00149
Axial 1 resilient def. (mm)	0.21033	0.212747	0.212747	0.21033	0.21033	0.211297	0.001324
Axial 2 resilient def. (mm)	0.220977	0.225861	0.220977	0.223419	0.220977	0.222442	0.002184
Actuator resilient def. (mm)	0.32967	0.344322	0.336996	0.336996	0.336996	0.336996	0.00518

Average permanent def. (mm)	1.063236	1.063236	1.063236	1.063236	1.063236	1.063236	0
Axial 1 permanent def. (mm)	1.056703	1.056703	1.056703	1.056703	1.056703	1.056703	0
Axial 2 permanent def. (mm)	1.069768	1.069768	1.069768	1.069768	1.069768	1.069768	0
Actuator permanent def. (mm)	1.084249	1.084249	1.084249	1.084249	1.084249	1.084249	0
Sequence Number	10						
Cycle Number	496	497	498	499	500	Average	Std Dev.
Resilient Modulus (MPa)	320.689099	317.718465	320.689099	323.177233	321.35522	320.725823	1.96548
Resilient micro-strain	1078.144078	1084.310134	1078.144078	1065.995116	1072.039072	1075.726496	6.958181
Confining pressure (kPa)	49.81685	50.40293	50.40293	50.40293	50.695971	50.344322	0.32101
Maximum axial stress (kPa)	350.72386	349.480158	349.480158	349.480158	349.480158	349.728899	0.5562
Cyclic stress (kPa)	345.749053	344.505352	345.749053	344.505352	344.505352	345.002832	0.681203
Contact stress (kPa)	4.974807	4.974807	3.731105	4.974807	4.974807	4.726066	0.5562
Permanent strain (%)	0.53406	0.532839	0.53406	0.53406	0.533455	0.533695	0.000545
Maximum load (kN)	2.754579	2.744811	2.744811	2.744811	2.744811	2.746764	0.004368
Cyclic load (kN)	2.715507	2.705739	2.715507	2.705739	2.705739	2.709646	0.00535
Contact load (kN)	0.039072	0.039072	0.029304	0.039072	0.039072	0.037118	0.004368
Average resilient def. (mm)	0.215629	0.216862	0.215629	0.213199	0.214408	0.215145	0.001392
Axial 1 resilient def. (mm)	0.21033	0.21033	0.21033	0.207912	0.21033	0.209846	0.001081
Axial 2 resilient def. (mm)	0.220928	0.223394	0.220928	0.218486	0.218486	0.220444	0.002052
Actuator resilient def. (mm)	0.344322	0.344322	0.344322	0.32967	0.32967	0.338462	0.008025
Average permanent def. (mm)	1.06812	1.065678	1.06812	1.06812	1.066911	1.067389	0.001091
Axial 1 permanent def. (mm)	1.061538	1.059121	1.061538	1.061538	1.059121	1.060571	0.001324
Axial 2 permanent def. (mm)	1.074701	1.072234	1.074701	1.074701	1.074701	1.074208	0.001103
Actuator permanent def. (mm)	1.091575	1.084249	1.091575	1.091575	1.091575	1.09011	0.003276
Sequence Number	11						
Cycle Number	496	497	498	499	500	Average	Std Dev.
Resilient Modulus (MPa)	325.057469	320.725422	315.367496	320.707259	323.214254	321.01438	3.648669
Resilient micro-strain	1059.82906	1078.021978	1096.336996	1078.083028	1065.873016	1075.628816	14.012379
Confining pressure (kPa)	50.10989	50.40293	50.40293	49.81685	50.10989	50.168498	0.245175
Maximum axial stress (kPa)	349.480158	350.72386	350.72386	350.72386	349.480158	350.226379	0.681203
Cyclic stress (kPa)	344.505352	345.749053	345.749053	345.749053	344.505352	345.251573	0.681203
Contact stress (kPa)	4.974807	4.974807	4.974807	4.974807	4.974807	4.974807	0
Permanent strain (%)	0.536502	0.536502	0.535281	0.535281	0.536502	0.536013	0.000669
Maximum load (kN)	2.744811	2.754579	2.754579	2.754579	2.744811	2.750672	0.00535
Cyclic load (kN)	2.705739	2.715507	2.715507	2.715507	2.705739	2.7116	0.00535
Contact load (kN)	0.039072	0.039072	0.039072	0.039072	0.039072	0.039072	0
Average resilient def. (mm)	0.211966	0.215604	0.219267	0.215617	0.213175	0.215126	0.002802
Axial 1 resilient def. (mm)	0.205495	0.21033	0.212747	0.21033	0.207912	0.209363	0.002756
Axial 2 resilient def. (mm)	0.218437	0.220879	0.225788	0.220904	0.218437	0.220889	0.003001
Actuator resilient def. (mm)	0.322344	0.336996	0.351648	0.336996	0.32967	0.335531	0.010866
Average permanent def. (mm)	1.073004	1.073004	1.070562	1.070562	1.073004	1.072027	0.001338
Axial 1 permanent def. (mm)	1.066374	1.066374	1.063956	1.063956	1.066374	1.065407	0.001324
Axial 2 permanent def. (mm)	1.079634	1.079634	1.077167	1.077167	1.079634	1.078647	0.001351
Actuator permanent def. (mm)	1.106227	1.106227	1.098901	1.098901	1.106227	1.103297	0.004013
Sequence Number	12						
Cycle Number	496	497	498	499	500	Average	Std Dev.
Resilient Modulus (MPa)	326.978657	326.978657	328.159085	326.978657	326.978657	327.214743	0.527904
Resilient micro-strain	1053.601954	1053.601954	1053.601954	1053.601954	1053.601954	1053.601954	0
Confining pressure (kPa)	50.695971	50.40293	50.40293	50.40293	50.40293	50.461538	0.131052
Maximum axial stress (kPa)	349.480158	349.480158	350.72386	349.480158	349.480158	349.728899	0.5562
Cyclic stress (kPa)	344.505352	344.505352	345.749053	344.505352	344.505352	344.754092	0.5562
Contact stress (kPa)	4.974807	4.974807	4.974807	4.974807	4.974807	4.974807	0
Permanent strain (%)	0.538944	0.538944	0.538944	0.538944	0.538944	0.538944	0
Maximum load (kN)	2.744811	2.744811	2.754579	2.744811	2.744811	2.746764	0.004368
Cyclic load (kN)	2.705739	2.705739	2.715507	2.705739	2.705739	2.707692	0.004368
Contact load (kN)	0.039072	0.039072	0.039072	0.039072	0.039072	0.039072	0
Average resilient def. (mm)	0.21072	0.21072	0.21072	0.21072	0.21072	0.21072	0
Axial 1 resilient def. (mm)	0.205495	0.205495	0.205495	0.205495	0.205495	0.205495	0
Axial 2 resilient def. (mm)	0.215946	0.215946	0.215946	0.215946	0.215946	0.215946	0
Actuator resilient def. (mm)	0.32967	0.322344	0.32967	0.32967	0.32967	0.328205	0.003276
Average permanent def. (mm)	1.077888	1.077888	1.077888	1.077888	1.077888	1.077888	0
Axial 1 permanent def. (mm)	1.071209	1.071209	1.071209	1.071209	1.071209	1.071209	0
Axial 2 permanent def. (mm)	1.084567	1.084567	1.084567	1.084567	1.084567	1.084567	0
Actuator permanent def. (mm)	1.098901	1.098901	1.098901	1.098901	1.098901	1.098901	0
Sequence Number	13						
Cycle Number	496	497	498	499	500	Average	Std Dev.
Resilient Modulus (MPa)	328.19712	326.324949	327.016554	327.016554	323.767663	326.464568	1.651053
Resilient micro-strain	1053.479853	1059.52381	1053.479853	1053.479853	1071.733822	1058.339438	7.931881
Confining pressure (kPa)	50.40293	50.40293	50.695971	50.40293	50.40293	50.461538	0.131052
Maximum axial stress (kPa)	350.72386	350.72386	349.480158	349.480158	351.967562	350.47512	1.040555
Cyclic stress (kPa)	345.749053	345.749053	344.505352	344.505352	346.992755	345.500313	1.040555
Contact stress (kPa)	4.974807	4.974807	4.974807	4.974807	4.974807	4.974807	0
Permanent strain (%)	0.541386	0.541386	0.541386	0.541386	0.541386	0.541386	0
Maximum load (kN)	2.754579	2.754579	2.744811	2.744811	2.764347	2.752625	0.008173
Cyclic load (kN)	2.715507	2.715507	2.705739	2.705739	2.725275	2.713553	0.008173
Contact load (kN)	0.039072	0.039072	0.039072	0.039072	0.039072	0.039072	0
Average resilient def. (mm)	0.210696	0.211905	0.210696	0.210696	0.214347	0.211668	0.001586

Axial 1 resilient def. (mm)	0.205495	0.207912	0.205495	0.205495	0.207912	0.206462	0.001324
Axial 2 resilient def. (mm)	0.215897	0.215897	0.215897	0.215897	0.220781	0.216874	0.002184
Actuator resilient def. (mm)	0.336996	0.32967	0.32967	0.32967	0.336996	0.332601	0.004013
Average permanent def. (mm)	1.082772	1.082772	1.082772	1.082772	1.082772	1.082772	0
Axial 1 permanent def. (mm)	1.076044	1.076044	1.076044	1.076044	1.076044	1.076044	0
Axial 2 permanent def. (mm)	1.089499	1.089499	1.089499	1.089499	1.089499	1.089499	0
Actuator permanent def. (mm)	1.098901	1.106227	1.106227	1.106227	1.106227	1.104762	0.003276
Sequence Number	14						
Cycle Number	496	497	498	499	500	Average	Std Dev.
Resilient Modulus (MPa)	328.21614	324.474017	328.92269	332.045585	328.92269	328.516224	2.702605
Resilient micro-strain	1053.418803	1065.567766	1047.374847	1041.269841	1047.374847	1051.001221	9.206382
Confining pressure (kPa)	50.40293	50.10989	50.40293	50.40293	50.40293	50.344322	0.131052
Maximum axial stress (kPa)	350.72386	350.72386	349.480158	350.72386	349.480158	350.226379	0.681203
Cyclic stress (kPa)	345.749053	345.749053	344.505352	345.749053	344.505352	345.251573	0.681203
Contact stress (kPa)	4.974807	4.974807	4.974807	4.974807	4.974807	4.974807	0
Permanent strain (%)	0.542607	0.542607	0.542607	0.542607	0.542607	0.542607	0
Maximum load (kN)	2.754579	2.754579	2.744811	2.754579	2.744811	2.750672	0.00535
Cyclic load (kN)	2.715507	2.715507	2.705739	2.715507	2.705739	2.7116	0.00535
Contact load (kN)	0.039072	0.039072	0.039072	0.039072	0.039072	0.039072	0
Average resilient def. (mm)	0.210684	0.213114	0.209475	0.208254	0.209475	0.2102	0.001841
Axial 1 resilient def. (mm)	0.205495	0.207912	0.203077	0.203077	0.203077	0.204527	0.002162
Axial 2 resilient def. (mm)	0.215873	0.218315	0.215873	0.213431	0.215873	0.215873	0.001727
Actuator resilient def. (mm)	0.32967	0.336996	0.32967	0.32967	0.32967	0.331136	0.003276
Average permanent def. (mm)	1.085214	1.085214	1.085214	1.085214	1.085214	1.085214	0
Axial 1 permanent def. (mm)	1.078462	1.078462	1.078462	1.078462	1.078462	1.078462	0
Axial 2 permanent def. (mm)	1.091966	1.091966	1.091966	1.091966	1.091966	1.091966	0
Actuator permanent def. (mm)	1.113553	1.113553	1.113553	1.113553	1.106227	1.112088	0.003276
Sequence Number	15						
Cycle Number	496	497	498	499	500	Average	Std Dev.
Resilient Modulus (MPa)	334.796658	336.00531	333.568215	334.003863	332.80241	334.235291	1.224724
Resilient micro-strain	1028.998779	1028.998779	1029.059829	1035.164835	1035.164835	1031.477411	3.366234
Confining pressure (kPa)	50.10989	50.40293	50.40293	50.40293	50.40293	50.344322	0.131052
Maximum axial stress (kPa)	349.480158	350.72386	349.480158	350.72386	349.480158	349.977639	0.681203
Cyclic stress (kPa)	344.505352	345.749053	343.26165	345.749053	344.505352	344.754092	1.040555
Contact stress (kPa)	4.974807	4.974807	6.218508	4.974807	4.974807	5.223547	0.5562
Permanent strain (%)	0.545049	0.545049	0.543828	0.543828	0.543828	0.544316	0.000669
Maximum load (kN)	2.744811	2.754579	2.744811	2.754579	2.744811	2.748718	0.00535
Cyclic load (kN)	2.705739	2.715507	2.695971	2.715507	2.705739	2.707692	0.008173
Contact load (kN)	0.039072	0.039072	0.04884	0.039072	0.039072	0.041026	0.004368
Average resilient def. (mm)	0.2058	0.2058	0.205812	0.207033	0.207033	0.206295	0.000673
Axial 1 resilient def. (mm)	0.200659	0.200659	0.200659	0.200659	0.200659	0.200659	0
Axial 2 resilient def. (mm)	0.21094	0.21094	0.210965	0.213407	0.213407	0.211932	0.001346
Actuator resilient def. (mm)	0.32967	0.32967	0.32967	0.32967	0.32967	0.32967	0
Average permanent def. (mm)	1.090098	1.090098	1.087656	1.087656	1.087656	1.088632	0.001338
Axial 1 permanent def. (mm)	1.083297	1.083297	1.080879	1.080879	1.080879	1.081846	0.001324
Axial 2 permanent def. (mm)	1.096899	1.096899	1.094432	1.094432	1.094432	1.095419	0.001351
Actuator permanent def. (mm)	1.106227	1.106227	1.106227	1.106227	1.106227	1.106227	0
Sequence Number	16						
Cycle Number	496	497	498	499	500	Average	Std Dev.
Resilient Modulus (MPa)	334.023562	334.796658	338.817032	338.817032	332.822038	335.855264	2.79376
Resilient micro-strain	1035.103785	1028.998779	1016.788767	1016.788767	1035.103785	1026.556777	9.2587
Confining pressure (kPa)	50.40293	50.10989	49.81685	50.40293	50.40293	50.227106	0.262103
Maximum axial stress (kPa)	350.72386	349.480158	349.480158	350.72386	349.480158	349.977639	0.681203
Cyclic stress (kPa)	345.749053	344.505352	344.505352	344.505352	344.505352	344.754092	0.5562
Contact stress (kPa)	4.974807	4.974807	4.974807	6.218508	4.974807	5.223547	0.5562
Permanent strain (%)	0.545049	0.545049	0.54627	0.54627	0.545049	0.545537	0.000669
Maximum load (kN)	2.754579	2.744811	2.744811	2.754579	2.744811	2.748718	0.00535
Cyclic load (kN)	2.715507	2.705739	2.705739	2.705739	2.705739	2.707692	0.004368
Contact load (kN)	0.039072	0.039072	0.039072	0.04884	0.039072	0.041026	0.004368
Average resilient def. (mm)	0.207021	0.2058	0.203358	0.203358	0.207021	0.205311	0.001852
Axial 1 resilient def. (mm)	0.200659	0.200659	0.198242	0.198242	0.200659	0.199692	0.001324
Axial 2 resilient def. (mm)	0.213382	0.21094	0.208474	0.208474	0.213382	0.21093	0.002454
Actuator resilient def. (mm)	0.322344	0.322344	0.322344	0.322344	0.32967	0.32381	0.003276
Average permanent def. (mm)	1.090098	1.090098	1.09254	1.09254	1.090098	1.091074	0.001338
Axial 1 permanent def. (mm)	1.083297	1.083297	1.085714	1.085714	1.083297	1.084264	0.001324
Axial 2 permanent def. (mm)	1.096899	1.096899	1.099365	1.099365	1.096899	1.097885	0.001351
Actuator permanent def. (mm)	1.113553	1.113553	1.113553	1.113553	1.106227	1.112088	0.003276
Sequence Number	17						
Cycle Number	496	497	498	499	500	Average	Std Dev.
Resilient Modulus (MPa)	338.817032	336.794847	338.817032	342.914296	338.817032	339.232048	2.236941
Resilient micro-strain	1016.788767	1022.893773	1016.788767	1004.639805	1016.788767	1015.579976	6.662629
Confining pressure (kPa)	50.40293	50.40293	50.40293	50.40293	50.40293	50.40293	0
Maximum axial stress (kPa)	349.480158	349.480158	349.480158	349.480158	349.480158	349.480158	0
Cyclic stress (kPa)	344.505352	344.505352	344.505352	344.505352	344.505352	344.505352	0
Contact stress (kPa)	4.974807	4.974807	4.974807	4.974807	4.974807	4.974807	0
Permanent strain (%)	0.54627	0.54627	0.54627	0.54627	0.54627	0.54627	0
Maximum load (kN)	2.744811	2.744811	2.744811	2.744811	2.744811	2.744811	0

Cyclic load (kN)	2.705739	2.705739	2.705739	2.705739	2.705739	2.705739	0
Contact load (kN)	0.039072	0.039072	0.039072	0.039072	0.039072	0.039072	0
Average resilient def. (mm)	0.203358	0.204579	0.203358	0.200928	0.203358	0.203116	0.001333
Axial 1 resilient def. (mm)	0.198242	0.198242	0.198242	0.195824	0.198242	0.197758	0.001081
Axial 2 resilient def. (mm)	0.208474	0.210916	0.208474	0.206032	0.208474	0.208474	0.001727
Actuator resilient def. (mm)	0.322344	0.322344	0.322344	0.322344	0.322344	0.322344	0
Average permanent def. (mm)	1.09254	1.09254	1.09254	1.09254	1.09254	1.09254	0
Axial 1 permanent def. (mm)	1.085714	1.085714	1.085714	1.085714	1.085714	1.085714	0
Axial 2 permanent def. (mm)	1.099365	1.099365	1.099365	1.099365	1.099365	1.099365	0
Actuator permanent def. (mm)	1.113553	1.113553	1.113553	1.113553	1.113553	1.113553	0
Sequence Number	18						
Cycle Number	496	497	498	499	500	Average	Std Dev.
Resilient Modulus (MPa)	340.863646	340.843058	344.152254	345.010862	340.843058	342.342576	2.066339
Resilient micro-strain	1010.683761	1010.744811	1004.639805	998.534799	1010.744811	1007.069597	5.450304
Confining pressure (kPa)	50.40293	50.40293	50.40293	50.10989	50.695971	50.40293	0.207211
Maximum axial stress (kPa)	349.480158	349.480158	350.72386	349.480158	349.480158	349.728899	0.5562
Cyclic stress (kPa)	344.505352	344.505352	345.749053	344.505352	344.505352	344.754092	0.5562
Contact stress (kPa)	4.974807	4.974807	4.974807	4.974807	4.974807	4.974807	0
Permanent strain (%)	0.548095	0.546874	0.548095	0.548095	0.546874	0.547607	0.000669
Maximum load (kN)	2.744811	2.744811	2.754579	2.744811	2.744811	2.746764	0.004368
Cyclic load (kN)	2.705739	2.705739	2.715507	2.705739	2.705739	2.707692	0.004368
Contact load (kN)	0.039072	0.039072	0.039072	0.039072	0.039072	0.039072	0
Average resilient def. (mm)	0.202137	0.202149	0.200928	0.199707	0.202149	0.201414	0.00109
Axial 1 resilient def. (mm)	0.195824	0.195824	0.193407	0.193407	0.195824	0.194857	0.001324
Axial 2 resilient def. (mm)	0.208449	0.208474	0.208449	0.206007	0.208474	0.207971	0.001098
Actuator resilient def. (mm)	0.322344	0.315018	0.315018	0.315018	0.315018	0.316484	0.003276
Average permanent def. (mm)	1.09619	1.093748	1.09619	1.09619	1.093748	1.095214	0.001338
Axial 1 permanent def. (mm)	1.090549	1.088132	1.090549	1.090549	1.088132	1.089582	0.001324
Axial 2 permanent def. (mm)	1.101832	1.099365	1.101832	1.101832	1.099365	1.100845	0.001351
Actuator permanent def. (mm)	1.120879	1.120879	1.120879	1.120879	1.120879	1.120879	0
Sequence Number	19						
Cycle Number	496	497	498	499	500	Average	Std Dev.
Resilient Modulus (MPa)	344.194086	344.194086	344.194086	340.081036	344.194086	343.371476	1.839412
Resilient micro-strain	1004.517705	1004.517705	1004.517705	1016.666667	1004.517705	1006.947497	5.433181
Confining pressure (kPa)	50.40293	50.40293	50.40293	50.40293	50.40293	50.40293	0
Maximum axial stress (kPa)	350.72386	350.72386	350.72386	350.72386	350.72386	350.72386	0
Cyclic stress (kPa)	345.749053	345.749053	345.749053	345.749053	345.749053	345.749053	0
Contact stress (kPa)	4.974807	4.974807	4.974807	4.974807	4.974807	4.974807	0
Permanent strain (%)	0.548712	0.548712	0.548712	0.548712	0.548712	0.548712	0
Maximum load (kN)	2.754579	2.754579	2.754579	2.754579	2.754579	2.754579	0
Cyclic load (kN)	2.715507	2.715507	2.715507	2.715507	2.715507	2.715507	0
Contact load (kN)	0.039072	0.039072	0.039072	0.039072	0.039072	0.039072	0
Average resilient def. (mm)	0.200904	0.200904	0.200904	0.203333	0.200904	0.201389	0.001087
Axial 1 resilient def. (mm)	0.195824	0.195824	0.195824	0.198242	0.195824	0.196308	0.001081
Axial 2 resilient def. (mm)	0.205983	0.205983	0.205983	0.208425	0.205983	0.206471	0.001092
Actuator resilient def. (mm)	0.315018	0.32967	0.32967	0.32967	0.322344	0.325275	0.006553
Average permanent def. (mm)	1.097424	1.097424	1.097424	1.097424	1.097424	1.097424	0
Axial 1 permanent def. (mm)	1.090549	1.090549	1.090549	1.090549	1.090549	1.090549	0
Axial 2 permanent def. (mm)	1.104298	1.104298	1.104298	1.104298	1.104298	1.104298	0
Actuator permanent def. (mm)	1.120879	1.113553	1.113553	1.113553	1.113553	1.115018	0.003276
Sequence Number	20						
Cycle Number	496	497	498	499	500	Average	Std Dev.
Resilient Modulus (MPa)	376.182914	379.030649	376.182914	374.24712	379.030649	376.934849	2.069992
Resilient micro-strain	1180.28083	1168.131868	1180.28083	1186.385836	1168.131868	1176.642247	8.158879
Confining pressure (kPa)	50.40293	50.40293	50.40293	50.10989	50.40293	50.344322	0.131052
Maximum axial stress (kPa)	450.21999	448.976289	450.21999	450.21999	448.976289	449.72251	0.681203
Cyclic stress (kPa)	444.001482	442.757781	444.001482	444.001482	442.757781	443.504002	0.681203
Contact stress (kPa)	6.218508	6.218508	6.218508	6.218508	6.218508	6.218508	0
Permanent strain (%)	0.556654	0.556654	0.556654	0.556654	0.556654	0.556654	0
Maximum load (kN)	3.53602	3.526252	3.53602	3.53602	3.526252	3.532112	0.00535
Cyclic load (kN)	3.487179	3.477411	3.487179	3.487179	3.477411	3.483272	0.00535
Contact load (kN)	0.04884	0.04884	0.04884	0.04884	0.04884	0.04884	0
Average resilient def. (mm)	0.236056	0.233626	0.236056	0.237277	0.233626	0.235328	0.001632
Axial 1 resilient def. (mm)	0.22967	0.227253	0.22967	0.22967	0.227253	0.228703	0.001324
Axial 2 resilient def. (mm)	0.242442	0.24	0.242442	0.244884	0.24	0.241954	0.002043
Actuator resilient def. (mm)	0.388278	0.380952	0.388278	0.388278	0.380952	0.385348	0.004013
Average permanent def. (mm)	1.113309	1.113309	1.113309	1.113309	1.113309	1.113309	0
Axial 1 permanent def. (mm)	1.105055	1.105055	1.105055	1.105055	1.105055	1.105055	0
Axial 2 permanent def. (mm)	1.121563	1.121563	1.121563	1.121563	1.121563	1.121563	0
Actuator permanent def. (mm)	1.135531	1.135531	1.135531	1.135531	1.135531	1.135531	0
Sequence Number	21						
Cycle Number	496	497	498	499	500	Average	Std Dev.
Resilient Modulus (MPa)	374.304904	371.345235	375.1874	373.256431	374.304904	373.679775	1.473415
Resilient micro-strain	1186.202686	1192.307692	1180.09768	1186.202686	1186.202686	1186.202686	4.316891
Confining pressure (kPa)	50.40293	50.40293	50.10989	50.10989	50.40293	50.285714	0.160505
Maximum axial stress (kPa)	450.21999	448.976289	448.976289	448.976289	450.21999	449.473769	0.681203
Cyclic stress (kPa)	444.001482	442.757781	442.757781	442.757781	444.001482	443.255261	0.681203

Contact stress (kPa)	6.218508	6.218508	6.218508	6.218508	6.218508	6.218508	0
Permanent strain (%)	0.560317	0.559096	0.560317	0.560317	0.560317	0.560073	0.000546
Maximum load (kN)	3.53602	3.526252	3.526252	3.526252	3.53602	3.530159	0.00535
Cyclic load (kN)	3.487179	3.477411	3.477411	3.477411	3.487179	3.481319	0.00535
Contact load (kN)	0.04884	0.04884	0.04884	0.04884	0.04884	0.04884	0
Average resilient def. (mm)	0.237241	0.238462	0.23602	0.237241	0.237241	0.237241	0.000863
Axial 1 resilient def. (mm)	0.22967	0.232088	0.22967	0.22967	0.22967	0.230154	0.001081
Axial 2 resilient def. (mm)	0.244811	0.244835	0.242369	0.244811	0.244811	0.244327	0.001095
Actuator resilient def. (mm)	0.395604	0.388278	0.388278	0.388278	0.388278	0.389744	0.003276
Average permanent def. (mm)	1.120635	1.118193	1.120635	1.120635	1.120635	1.120147	0.001092
Axial 1 permanent def. (mm)	1.112308	1.10989	1.112308	1.112308	1.112308	1.111824	0.001081
Axial 2 permanent def. (mm)	1.128962	1.126496	1.128962	1.128962	1.128962	1.128469	0.001103
Actuator permanent def. (mm)	1.142857	1.142857	1.150183	1.150183	1.150183	1.147253	0.004013
Sequence Number	22						
Cycle Number	496	497	498	499	500	Average	Std Dev.
Resilient Modulus (MPa)	376.299699	377.35376	381.162161	379.149542	374.381977	377.669428	2.60639
Resilient micro-strain	1179.91453	1179.91453	1161.599512	1167.765568	1185.958486	1175.030525	10.003738
Confining pressure (kPa)	50.40293	50.40293	50.40293	50.10989	50.40293	50.344322	0.131052
Maximum axial stress (kPa)	450.21999	450.21999	448.976289	448.976289	450.21999	449.72251	0.681203
Cyclic stress (kPa)	444.001482	445.245184	442.757781	442.757781	444.001482	443.752742	1.040555
Contact stress (kPa)	6.218508	4.974807	6.218508	6.218508	6.218508	5.969768	0.5562
Permanent strain (%)	0.563376	0.56398	0.564597	0.56398	0.563376	0.563862	0.00051
Maximum load (kN)	3.53602	3.53602	3.526252	3.526252	3.53602	3.532112	0.00535
Cyclic load (kN)	3.487179	3.496947	3.477411	3.477411	3.487179	3.485226	0.008173
Contact load (kN)	0.04884	0.039072	0.04884	0.04884	0.04884	0.046886	0.004368
Average resilient def. (mm)	0.235983	0.235983	0.23232	0.233553	0.237192	0.235006	0.002001
Axial 1 resilient def. (mm)	0.22967	0.22967	0.227253	0.227253	0.232088	0.229187	0.002023
Axial 2 resilient def. (mm)	0.242295	0.242295	0.237387	0.239853	0.242295	0.240825	0.002194
Actuator resilient def. (mm)	0.380952	0.388278	0.380952	0.373626	0.388278	0.382418	0.006129
Average permanent def. (mm)	1.126752	1.127961	1.129194	1.127961	1.126752	1.127724	0.00102
Axial 1 permanent def. (mm)	1.117143	1.11956	1.11956	1.11956	1.117143	1.118593	0.001324
Axial 2 permanent def. (mm)	1.136361	1.136361	1.138828	1.136361	1.136361	1.136855	0.001103
Actuator permanent def. (mm)	1.142857	1.142857	1.150183	1.150183	1.142857	1.145788	0.004013
Sequence Number	23						
Cycle Number	496	497	498	499	500	Average	Std Dev.
Resilient Modulus (MPa)	377.547479	378.296191	377.392813	380.254328	373.371728	377.372508	2.509748
Resilient micro-strain	1185.897436	1173.687424	1179.79243	1167.643468	1185.836386	1178.571429	7.924876
Confining pressure (kPa)	50.10989	50.695971	50.40293	50.10989	50.10989	50.285714	0.262103
Maximum axial stress (kPa)	452.707394	450.21999	451.463692	450.21999	448.976289	450.717471	1.418038
Cyclic stress (kPa)	447.732587	444.001482	445.245184	444.001482	442.757781	444.747703	1.886167
Contact stress (kPa)	4.974807	6.218508	6.218508	6.218508	6.218508	5.969768	0.5562
Permanent strain (%)	0.566422	0.565818	0.566422	0.566422	0.565818	0.566181	0.000331
Maximum load (kN)	3.555556	3.53602	3.545788	3.53602	3.526252	3.539927	0.011137
Cyclic load (kN)	3.516484	3.487179	3.496947	3.487179	3.477411	3.49304	0.014814
Contact load (kN)	0.039072	0.04884	0.04884	0.04884	0.04884	0.046886	0.004368
Average resilient def. (mm)	0.237179	0.234737	0.235958	0.233529	0.237167	0.235714	0.001585
Axial 1 resilient def. (mm)	0.22967	0.22967	0.22967	0.227253	0.232088	0.22967	0.001709
Axial 2 resilient def. (mm)	0.244689	0.239805	0.242247	0.239805	0.242247	0.241758	0.002043
Actuator resilient def. (mm)	0.388278	0.388278	0.388278	0.380952	0.388278	0.386813	0.003276
Average permanent def. (mm)	1.132845	1.131636	1.132845	1.132845	1.131636	1.132361	0.000662
Axial 1 permanent def. (mm)	1.124396	1.121978	1.124396	1.124396	1.121978	1.123429	0.001324
Axial 2 permanent def. (mm)	1.141294	1.141294	1.141294	1.141294	1.141294	1.141294	0
Actuator permanent def. (mm)	1.157509	1.150183	1.150183	1.157509	1.150183	1.153114	0.004013
Sequence Number	24						
Cycle Number	496	497	498	499	500	Average	Std Dev.
Resilient Modulus (MPa)	379.355845	380.274211	377.412343	376.358118	378.296191	378.339342	1.54624
Resilient micro-strain	1173.687424	1167.582418	1179.73138	1179.73138	1173.687424	1174.884005	5.078653
Confining pressure (kPa)	50.695971	50.40293	50.10989	50.40293	49.81685	50.285714	0.334117
Maximum axial stress (kPa)	450.21999	448.976289	450.21999	450.21999	448.976289	449.72251	0.681203
Cyclic stress (kPa)	445.245184	444.001482	445.245184	444.001482	444.001482	444.498963	0.681203
Contact stress (kPa)	4.974807	4.974807	4.974807	6.218508	4.974807	5.223547	0.5562
Permanent strain (%)	0.567643	0.567643	0.567643	0.567643	0.567643	0.567643	0
Maximum load (kN)	3.53602	3.526252	3.53602	3.53602	3.526252	3.532112	0.00535
Cyclic load (kN)	3.496947	3.487179	3.496947	3.487179	3.487179	3.491087	0.00535
Contact load (kN)	0.039072	0.039072	0.039072	0.04884	0.039072	0.041026	0.004368
Average resilient def. (mm)	0.234737	0.233516	0.235946	0.235946	0.234737	0.234977	0.001016
Axial 1 resilient def. (mm)	0.227253	0.227253	0.22967	0.22967	0.227253	0.22822	0.001324
Axial 2 resilient def. (mm)	0.242222	0.23978	0.242222	0.242222	0.242222	0.241734	0.001092
Actuator resilient def. (mm)	0.388278	0.380952	0.388278	0.388278	0.380952	0.385348	0.004013
Average permanent def. (mm)	1.135287	1.135287	1.135287	1.135287	1.135287	1.135287	0
Axial 1 permanent def. (mm)	1.126813	1.126813	1.126813	1.126813	1.126813	1.126813	0
Axial 2 permanent def. (mm)	1.143761	1.143761	1.143761	1.143761	1.143761	1.143761	0
Actuator permanent def. (mm)	1.157509	1.157509	1.157509	1.157509	1.157509	1.157509	0
Sequence Number	25						
Cycle Number	496	497	498	499	500	Average	Std Dev.
Resilient Modulus (MPa)	377.451408	380.313982	379.248677	376.397075	378.355233	378.353275	1.523664
Resilient micro-strain	1179.60928	1167.460317	1167.460317	1179.60928	1173.504274	1173.528694	6.074496

Confining pressure (kPa)	50.695971	50.695971	50.40293	50.40293	50.40293	50.520147	0.160505
Maximum axial stress (kPa)	450.21999	450.21999	448.976289	450.21999	450.21999	449.97125	0.5562
Cyclic stress (kPa)	445.245184	444.001482	442.757781	444.001482	444.001482	444.001482	0.87943
Contact stress (kPa)	4.974807	6.218508	6.218508	6.218508	6.218508	5.969768	0.5562
Permanent strain (%)	0.569481	0.570085	0.570085	0.569481	0.569481	0.569723	0.000331
Maximum load (kN)	3.53602	3.53602	3.526252	3.53602	3.53602	3.534066	0.004368
Cyclic load (kN)	3.496947	3.487179	3.477411	3.487179	3.487179	3.487179	0.006907
Contact load (kN)	0.039072	0.04884	0.04884	0.04884	0.04884	0.046886	0.004368
Average resilient def. (mm)	0.235922	0.233492	0.233492	0.235922	0.234701	0.234706	0.001215
Axial 1 resilient def. (mm)	0.22967	0.227253	0.227253	0.22967	0.22967	0.228703	0.001324
Axial 2 resilient def. (mm)	0.242173	0.239731	0.239731	0.242173	0.239731	0.240708	0.001338
Actuator resilient def. (mm)	0.380952	0.380952	0.373626	0.388278	0.388278	0.382418	0.006129
Average permanent def. (mm)	1.138962	1.140171	1.140171	1.138962	1.138962	1.139446	0.000662
Axial 1 permanent def. (mm)	1.129231	1.131648	1.131648	1.129231	1.129231	1.130198	0.001324
Axial 2 permanent def. (mm)	1.148694	1.148694	1.148694	1.148694	1.148694	1.148694	0
Actuator permanent def. (mm)	1.172161	1.172161	1.172161	1.164835	1.164835	1.169231	0.004013
Sequence Number	26						
Cycle Number	496	497	498	499	500	Average	Std Dev.
Resilient Modulus (MPa)	382.353414	379.454532	385.334066	383.277267	379.454532	381.974762	2.541059
Resilient micro-strain	1161.233211	1173.382173	1149.023199	1155.189255	1173.382173	1162.442002	10.880056
Confining pressure (kPa)	50.40293	50.40293	50.40293	50.10989	49.81685	50.227106	0.262103
Maximum axial stress (kPa)	450.21999	451.463692	448.976289	450.21999	451.463692	450.468731	1.040555
Cyclic stress (kPa)	444.001482	445.245184	442.757781	442.757781	445.245184	444.001482	1.243702
Contact stress (kPa)	6.218508	6.218508	6.218508	7.46221	6.218508	6.467248	0.5562
Permanent strain (%)	0.571923	0.571923	0.573144	0.572527	0.571923	0.572288	0.000545
Maximum load (kN)	3.53602	3.545788	3.526252	3.53602	3.545788	3.537973	0.008173
Cyclic load (kN)	3.487179	3.496947	3.477411	3.477411	3.496947	3.487179	0.009768
Contact load (kN)	0.04884	0.04884	0.04884	0.058608	0.04884	0.050794	0.004368
Average resilient def. (mm)	0.232247	0.234676	0.229805	0.231038	0.234676	0.232488	0.002176
Axial 1 resilient def. (mm)	0.227253	0.22967	0.224835	0.224835	0.22967	0.227253	0.002418
Axial 2 resilient def. (mm)	0.237241	0.239683	0.234774	0.237241	0.239683	0.237724	0.002052
Actuator resilient def. (mm)	0.388278	0.388278	0.380952	0.380952	0.388278	0.385348	0.004013
Average permanent def. (mm)	1.143846	1.143846	1.146288	1.145055	1.143846	1.144576	0.001091
Axial 1 permanent def. (mm)	1.134066	1.134066	1.136484	1.136484	1.134066	1.135033	0.001324
Axial 2 permanent def. (mm)	1.153626	1.153626	1.156093	1.153626	1.153626	1.15412	0.001103
Actuator permanent def. (mm)	1.157509	1.164835	1.164835	1.164835	1.164835	1.16337	0.003276
Sequence Number	27						
Cycle Number	496	497	498	499	500	Average	Std Dev.
Resilient Modulus (MPa)	383.297524	383.297524	385.35454	387.392364	381.302442	384.128879	2.319678
Resilient micro-strain	1155.128205	1155.128205	1148.962149	1142.918193	1161.172161	1152.661783	6.950141
Confining pressure (kPa)	50.10989	50.40293	50.40293	50.40293	50.40293	50.344322	0.131052
Maximum axial stress (kPa)	448.976289	448.976289	448.976289	448.976289	448.976289	448.976289	0
Cyclic stress (kPa)	442.757781	442.757781	442.757781	442.757781	442.757781	442.757781	0
Contact stress (kPa)	6.218508	6.218508	6.218508	6.218508	6.218508	6.218508	0
Permanent strain (%)	0.573748	0.573748	0.574365	0.574365	0.573144	0.573874	0.000512
Maximum load (kN)	3.526252	3.526252	3.526252	3.526252	3.526252	3.526252	0
Cyclic load (kN)	3.477411	3.477411	3.477411	3.477411	3.477411	3.477411	0
Contact load (kN)	0.04884	0.04884	0.04884	0.04884	0.04884	0.04884	0
Average resilient def. (mm)	0.231026	0.231026	0.229792	0.228584	0.232234	0.230532	0.00139
Axial 1 resilient def. (mm)	0.224835	0.224835	0.224835	0.222418	0.227253	0.224835	0.001709
Axial 2 resilient def. (mm)	0.237216	0.237216	0.23475	0.23475	0.237216	0.23623	0.001351
Actuator resilient def. (mm)	0.373626	0.380952	0.373626	0.373626	0.380952	0.376557	0.004013
Average permanent def. (mm)	1.147497	1.147497	1.14873	1.14873	1.146288	1.147748	0.001023
Axial 1 permanent def. (mm)	1.138901	1.138901	1.138901	1.138901	1.136484	1.138418	0.001081
Axial 2 permanent def. (mm)	1.156093	1.156093	1.158559	1.158559	1.156093	1.157079	0.001351
Actuator permanent def. (mm)	1.172161	1.164835	1.172161	1.172161	1.164835	1.169231	0.004013
Sequence Number	28						
Cycle Number	496	497	498	499	500	Average	Std Dev.
Resilient Modulus (MPa)	382.373516	384.374202	384.394518	382.373516	383.317783	383.366707	1.005819
Resilient micro-strain	1161.172161	1155.128205	1155.067155	1161.172161	1155.067155	1157.521368	3.332797
Confining pressure (kPa)	50.40293	50.10989	50.40293	50.40293	50.10989	50.285714	0.160505
Maximum axial stress (kPa)	450.21999	450.21999	450.21999	450.21999	448.976289	449.97125	0.5562
Cyclic stress (kPa)	444.001482	444.001482	444.001482	444.001482	442.757781	443.752742	0.5562
Contact stress (kPa)	6.218508	6.218508	6.218508	6.218508	6.218508	6.218508	0
Permanent strain (%)	0.574969	0.575574	0.574969	0.574969	0.574969	0.57509	0.00027
Maximum load (kN)	3.53602	3.53602	3.53602	3.53602	3.526252	3.534066	0.004368
Cyclic load (kN)	3.487179	3.487179	3.487179	3.487179	3.477411	3.485226	0.004368
Contact load (kN)	0.04884	0.04884	0.04884	0.04884	0.04884	0.04884	0
Average resilient def. (mm)	0.232234	0.231026	0.231013	0.232234	0.231013	0.231504	0.000667
Axial 1 resilient def. (mm)	0.224835	0.222418	0.224835	0.224835	0.224835	0.224352	0.001081
Axial 2 resilient def. (mm)	0.239634	0.239634	0.237192	0.239634	0.237192	0.238657	0.001338
Actuator resilient def. (mm)	0.380952	0.388278	0.380952	0.388278	0.380952	0.383883	0.004013
Average permanent def. (mm)	1.149939	1.151148	1.149939	1.149939	1.149939	1.150181	0.000541
Axial 1 permanent def. (mm)	1.141319	1.143736	1.141319	1.141319	1.141319	1.141802	0.001081
Axial 2 permanent def. (mm)	1.158559	1.158559	1.158559	1.158559	1.158559	1.158559	0
Actuator permanent def. (mm)	1.179487	1.172161	1.172161	1.172161	1.172161	1.173626	0.003276
Sequence Number	29						

Cycle Number	496	497	498	499	500	Average	Std Dev.
Resilient Modulus (MPa)	389.514606	382.433837	385.395496	383.338044	384.414836	385.019364	2.748905
Resilient micro-strain	1136.691087	1160.989011	1148.840049	1155.006105	1155.006105	1151.306471	9.23064
Confining pressure (kPa)	50.695971	50.10989	50.40293	50.40293	50.40293	50.40293	0.207211
Maximum axial stress (kPa)	448.976289	450.21999	448.976289	448.976289	450.21999	449.473769	0.681203
Cyclic stress (kPa)	442.757781	444.001482	442.757781	442.757781	444.001482	443.255261	0.681203
Contact stress (kPa)	6.218508	6.218508	6.218508	6.218508	6.218508	6.218508	0
Permanent strain (%)	0.576807	0.576807	0.576807	0.57619	0.57619	0.57656	0.000338
Maximum load (kN)	3.526252	3.53602	3.526252	3.526252	3.53602	3.530159	0.00535
Cyclic load (kN)	3.477411	3.487179	3.477411	3.477411	3.487179	3.481319	0.00535
Contact load (kN)	0.04884	0.04884	0.04884	0.04884	0.04884	0.04884	0
Average resilient def. (mm)	0.227338	0.232198	0.229768	0.231001	0.231001	0.230261	0.001846
Axial 1 resilient def. (mm)	0.222418	0.227253	0.224835	0.224835	0.224835	0.224835	0.001709
Axial 2 resilient def. (mm)	0.232259	0.237143	0.234701	0.237167	0.237167	0.235687	0.002192
Actuator resilient def. (mm)	0.373626	0.380952	0.380952	0.373626	0.380952	0.378022	0.004013
Average permanent def. (mm)	1.153614	1.153614	1.153614	1.152381	1.152381	1.153121	0.000675
Axial 1 permanent def. (mm)	1.143736	1.143736	1.143736	1.143736	1.143736	1.143736	0
Axial 2 permanent def. (mm)	1.163492	1.163492	1.163492	1.161026	1.161026	1.162505	0.001351
Actuator permanent def. (mm)	1.179487	1.179487	1.179487	1.179487	1.179487	1.179487	0
Sequence Number	30						
Cycle Number	496	497	498	499	500	Average	Std Dev.
Resilient Modulus (MPa)	390.629728	387.454453	392.71798	389.514606	385.415977	389.146549	2.82271
Resilient micro-strain	1136.630037	1142.735043	1130.586081	1136.691087	1148.778999	1139.084249	6.915304
Confining pressure (kPa)	50.40293	50.40293	50.40293	50.40293	49.81685	50.285714	0.262103
Maximum axial stress (kPa)	448.976289	448.976289	448.976289	448.976289	448.976289	448.976289	0
Cyclic stress (kPa)	444.001482	442.757781	444.001482	442.757781	442.757781	443.255261	0.681203
Contact stress (kPa)	4.974807	6.218508	4.974807	6.218508	6.218508	5.721028	0.681203
Permanent strain (%)	0.578632	0.578028	0.578632	0.578632	0.578028	0.578391	0.000331
Maximum load (kN)	3.526252	3.526252	3.526252	3.526252	3.526252	3.526252	0
Cyclic load (kN)	3.487179	3.477411	3.487179	3.477411	3.477411	3.481319	0.00535
Contact load (kN)	0.039072	0.04884	0.039072	0.04884	0.04884	0.044933	0.00535
Average resilient def. (mm)	0.227326	0.228547	0.226117	0.227338	0.229756	0.227817	0.001383
Axial 1 resilient def. (mm)	0.222418	0.222418	0.22	0.22	0.224835	0.221934	0.002023
Axial 2 resilient def. (mm)	0.232234	0.234676	0.232234	0.234676	0.234676	0.2337	0.001338
Actuator resilient def. (mm)	0.373626	0.380952	0.373626	0.380952	0.373626	0.376557	0.004013
Average permanent def. (mm)	1.157265	1.156056	1.157265	1.157265	1.156056	1.156781	0.000662
Axial 1 permanent def. (mm)	1.148571	1.146154	1.148571	1.148571	1.146154	1.147604	0.001324
Axial 2 permanent def. (mm)	1.165958	1.165958	1.165958	1.165958	1.165958	1.165958	0
Actuator permanent def. (mm)	1.179487	1.172161	1.179487	1.172161	1.179487	1.176557	0.004013
Sequence Number	31						
Cycle Number	496	497	498	499	500	Average	Std Dev.
Resilient Modulus (MPa)	390.650711	393.744093	387.454453	392.739188	388.542808	390.62625	2.673344
Resilient micro-strain	1136.568987	1124.481074	1142.735043	1130.525031	1142.735043	1135.409035	7.936625
Confining pressure (kPa)	50.40293	50.10989	50.40293	50.40293	50.40293	50.344322	0.131052
Maximum axial stress (kPa)	450.21999	448.976289	448.976289	450.21999	450.21999	449.72251	0.681203
Cyclic stress (kPa)	444.001482	442.757781	442.757781	444.001482	444.001482	443.504002	0.681203
Contact stress (kPa)	6.218508	6.218508	6.218508	6.218508	6.218508	6.218508	0
Permanent strain (%)	0.579249	0.579853	0.578632	0.579853	0.578632	0.579244	0.000611
Maximum load (kN)	3.53602	3.526252	3.526252	3.53602	3.53602	3.532112	0.00535
Cyclic load (kN)	3.487179	3.477411	3.477411	3.487179	3.487179	3.483272	0.00535
Contact load (kN)	0.04884	0.04884	0.04884	0.04884	0.04884	0.04884	0
Average resilient def. (mm)	0.227314	0.224896	0.228547	0.226105	0.228547	0.227082	0.001587
Axial 1 resilient def. (mm)	0.222418	0.217582	0.222418	0.22	0.222418	0.220967	0.002162
Axial 2 resilient def. (mm)	0.23221	0.23221	0.234676	0.23221	0.234676	0.233197	0.001351
Actuator resilient def. (mm)	0.373626	0.373626	0.373626	0.380952	0.380952	0.376557	0.004013
Average permanent def. (mm)	1.158498	1.159707	1.157265	1.159707	1.157265	1.158488	0.001221
Axial 1 permanent def. (mm)	1.148571	1.150989	1.148571	1.150989	1.148571	1.149538	0.001324
Axial 2 permanent def. (mm)	1.168425	1.168425	1.165958	1.168425	1.165958	1.167438	0.001351
Actuator permanent def. (mm)	1.179487	1.179487	1.179487	1.179487	1.179487	1.179487	0
Sequence Number	32						
Cycle Number	496	497	498	499	500	Average	Std Dev.
Resilient Modulus (MPa)	386.478068	386.478068	383.670404	386.478068	386.478068	385.916535	1.255625
Resilient micro-strain	1148.840049	1148.840049	1166.971917	1148.840049	1148.840049	1152.466422	8.108818
Confining pressure (kPa)	50.40293	50.40293	50.40293	50.40293	50.40293	50.40293	0
Maximum axial stress (kPa)	450.21999	450.21999	452.707394	450.21999	450.21999	450.717471	1.112401
Cyclic stress (kPa)	444.001482	444.001482	447.732587	444.001482	444.001482	444.747703	1.668601
Contact stress (kPa)	6.218508	6.218508	4.974807	6.218508	6.218508	5.969768	0.5562
Permanent strain (%)	0.579237	0.579237	0.580458	0.579237	0.579237	0.579481	0.000546
Maximum load (kN)	3.53602	3.53602	3.555556	3.53602	3.53602	3.539927	0.008737
Cyclic load (kN)	3.487179	3.487179	3.516484	3.487179	3.487179	3.49304	0.013105
Contact load (kN)	0.04884	0.04884	0.039072	0.04884	0.04884	0.046886	0.004368
Average resilient def. (mm)	0.229768	0.229768	0.233394	0.229768	0.229768	0.230493	0.001622
Axial 1 resilient def. (mm)	0.222418	0.222418	0.227253	0.222418	0.222418	0.223385	0.002162
Axial 2 resilient def. (mm)	0.237118	0.237118	0.239536	0.237118	0.237118	0.237602	0.001081
Actuator resilient def. (mm)	0.380952	0.380952	0.395604	0.380952	0.380952	0.383883	0.006553
Average permanent def. (mm)	1.158474	1.158474	1.160916	1.158474	1.158474	1.158962	0.001092
Axial 1 permanent def. (mm)	1.150989	1.150989	1.153407	1.150989	1.150989	1.151473	0.001081
Axial 2 permanent def. (mm)	1.165958	1.165958	1.168425	1.165958	1.165958	1.166452	0.001103

Actuator permanent def. (mm)	1.186813	1.186813	1.186813	1.186813	1.186813	1.186813	0
Sequence Number	33						
Cycle Number	496	497	498	499	500	Average	Std Dev.
Resilient Modulus (MPa)	384.496129	391.660228	391.660228	391.660228	389.556451	389.806653	3.105298
Resilient micro-strain	1154.761905	1130.46398	1130.46398	1130.46398	1136.568987	1136.544567	10.521319
Confining pressure (kPa)	50.40293	50.40293	50.989011	50.10989	50.40293	50.461538	0.32101
Maximum axial stress (kPa)	450.21999	448.976289	448.976289	448.976289	448.976289	449.225029	0.5562
Cyclic stress (kPa)	444.001482	442.757781	442.757781	442.757781	442.757781	443.006521	0.5562
Contact stress (kPa)	6.218508	6.218508	6.218508	6.218508	6.218508	6.218508	0
Permanent strain (%)	0.581074	0.581074	0.581074	0.581074	0.581074	0.581074	0
Maximum load (kN)	3.53602	3.526252	3.526252	3.526252	3.526252	3.528205	0.004368
Cyclic load (kN)	3.487179	3.477411	3.477411	3.477411	3.477411	3.479365	0.004368
Contact load (kN)	0.04884	0.04884	0.04884	0.04884	0.04884	0.04884	0
Average resilient def. (mm)	0.230952	0.226093	0.226093	0.226093	0.227314	0.227309	0.002104
Axial 1 resilient def. (mm)	0.224835	0.22	0.22	0.22	0.22	0.220967	0.002162
Axial 2 resilient def. (mm)	0.23707	0.232186	0.232186	0.232186	0.234628	0.233651	0.002184
Actuator resilient def. (mm)	0.380952	0.380952	0.373626	0.380952	0.380952	0.379487	0.003276
Average permanent def. (mm)	1.162149	1.162149	1.162149	1.162149	1.162149	1.162149	0
Axial 1 permanent def. (mm)	1.153407	1.153407	1.153407	1.153407	1.153407	1.153407	0
Axial 2 permanent def. (mm)	1.170891	1.170891	1.170891	1.170891	1.170891	1.170891	0
Actuator permanent def. (mm)	1.186813	1.179487	1.186813	1.179487	1.179487	1.182418	0.004013
Sequence Number	34						
Cycle Number	496	497	498	499	500	Average	Std Dev.
Resilient Modulus (MPa)	393.881838	393.808235	397.070555	394.84607	393.786852	394.67871	1.408641
Resilient micro-strain	1130.40293	1124.297924	1118.192918	1118.192918	1124.358974	1123.089133	5.111535
Confining pressure (kPa)	50.40293	50.40293	50.40293	50.40293	50.40293	50.40293	0
Maximum axial stress (kPa)	451.463692	448.976289	450.21999	448.976289	448.976289	449.72251	1.112401
Cyclic stress (kPa)	445.245184	442.757781	444.001482	441.514079	442.757781	443.255261	1.418038
Contact stress (kPa)	6.218508	6.218508	6.218508	7.46221	6.218508	6.467248	0.5562
Permanent strain (%)	0.582295	0.582295	0.583516	0.583516	0.582295	0.582784	0.000669
Maximum load (kN)	3.545788	3.526252	3.53602	3.526252	3.526252	3.532112	0.008737
Cyclic load (kN)	3.496947	3.477411	3.487179	3.467643	3.477411	3.481319	0.011137
Contact load (kN)	0.04884	0.04884	0.04884	0.058608	0.04884	0.050794	0.004368
Average resilient def. (mm)	0.226081	0.22486	0.223639	0.223639	0.224872	0.224618	0.001022
Axial 1 resilient def. (mm)	0.22	0.22	0.217582	0.217582	0.217582	0.218549	0.001324
Axial 2 resilient def. (mm)	0.232161	0.229719	0.229695	0.229695	0.232161	0.230686	0.001346
Actuator resilient def. (mm)	0.380952	0.373626	0.373626	0.373626	0.3663	0.373626	0.00518
Average permanent def. (mm)	1.164591	1.164591	1.167033	1.167033	1.164591	1.165568	0.001338
Axial 1 permanent def. (mm)	1.155824	1.155824	1.158242	1.158242	1.155824	1.156791	0.001324
Axial 2 permanent def. (mm)	1.173358	1.173358	1.175824	1.175824	1.173358	1.174344	0.001351
Actuator permanent def. (mm)	1.186813	1.186813	1.186813	1.186813	1.186813	1.186813	0
Sequence Number	35						
Cycle Number	496	497	498	499	500	Average	Std Dev.
Resilient Modulus (MPa)	394.914437	391.702536	395.958312	395.958312	389.672799	393.641279	2.822489
Resilient micro-strain	1124.297924	1130.34188	1118.192918	1118.192918	1142.612943	1126.727717	10.210192
Confining pressure (kPa)	50.40293	50.695971	50.40293	50.40293	50.40293	50.461538	0.131052
Maximum axial stress (kPa)	450.21999	448.976289	448.976289	448.976289	451.463692	449.72251	1.112401
Cyclic stress (kPa)	444.001482	442.757781	442.757781	442.757781	445.245184	443.504002	1.112401
Contact stress (kPa)	6.218508	6.218508	6.218508	6.218508	6.218508	6.218508	0
Permanent strain (%)	0.583516	0.583516	0.583516	0.583516	0.5829	0.583393	0.000276
Maximum load (kN)	3.53602	3.526252	3.526252	3.526252	3.545788	3.532112	0.008737
Cyclic load (kN)	3.487179	3.477411	3.477411	3.477411	3.496947	3.483272	0.008737
Contact load (kN)	0.04884	0.04884	0.04884	0.04884	0.04884	0.04884	0
Average resilient def. (mm)	0.22486	0.226068	0.223639	0.223639	0.228523	0.225346	0.002042
Axial 1 resilient def. (mm)	0.217582	0.22	0.217582	0.217582	0.22	0.218549	0.001324
Axial 2 resilient def. (mm)	0.232137	0.232137	0.229695	0.229695	0.237045	0.232142	0.003001
Actuator resilient def. (mm)	0.3663	0.373626	0.373626	0.373626	0.380952	0.373626	0.00518
Average permanent def. (mm)	1.167033	1.167033	1.167033	1.167033	1.1658	1.166786	0.000552
Axial 1 permanent def. (mm)	1.158242	1.158242	1.158242	1.158242	1.158242	1.158242	0
Axial 2 permanent def. (mm)	1.175824	1.175824	1.175824	1.175824	1.173358	1.175331	0.001103
Actuator permanent def. (mm)	1.194139	1.194139	1.186813	1.186813	1.186813	1.189744	0.004013
Sequence Number	36						
Cycle Number	496	497	498	499	500	Average	Std Dev.
Resilient Modulus (MPa)	395.936695	394.871554	394.914437	389.693621	390.671695	393.217601	2.824374
Resilient micro-strain	1118.253968	1124.420024	1124.297924	1142.551893	1136.507937	1129.206349	9.97964
Confining pressure (kPa)	50.40293	50.695971	50.40293	50.40293	50.40293	50.461538	0.131052
Maximum axial stress (kPa)	448.976289	450.21999	450.21999	451.463692	450.21999	450.21999	0.87943
Cyclic stress (kPa)	442.757781	444.001482	444.001482	445.245184	444.001482	444.001482	0.87943
Contact stress (kPa)	6.218508	6.218508	6.218508	6.218508	6.218508	6.218508	0
Permanent strain (%)	0.584725	0.583504	0.584121	0.584121	0.5829	0.583874	0.000695
Maximum load (kN)	3.526252	3.53602	3.53602	3.545788	3.53602	3.53602	0.006907
Cyclic load (kN)	3.477411	3.487179	3.487179	3.496947	3.487179	3.487179	0.006907
Contact load (kN)	0.04884	0.04884	0.04884	0.04884	0.04884	0.04884	0
Average resilient def. (mm)	0.223651	0.224884	0.22486	0.22851	0.227302	0.225841	0.001996
Axial 1 resilient def. (mm)	0.215165	0.215165	0.217582	0.22	0.22	0.217582	0.002418
Axial 2 resilient def. (mm)	0.232137	0.234603	0.232137	0.237021	0.234603	0.2341	0.002046
Actuator resilient def. (mm)	0.373626	0.373626	0.380952	0.380952	0.373626	0.376557	0.004013

Average permanent def. (mm)	1.169451	1.167009	1.168242	1.168242	1.1658	1.167748	0.00139
Axial 1 permanent def. (mm)	1.163077	1.160659	1.160659	1.160659	1.158242	1.160659	0.001709
Axial 2 permanent def. (mm)	1.175824	1.173358	1.175824	1.175824	1.173358	1.174838	0.001351
Actuator permanent def. (mm)	1.201465	1.194139	1.194139	1.194139	1.194139	1.195604	0.003276
Sequence Number	37						
Cycle Number	496	497	498	499	500	Average	Std Dev.
Resilient Modulus (MPa)	403.704928	402.551757	400.351777	402.551757	400.351777	401.902399	1.491752
Resilient micro-strain	1099.81685	1099.8779	1105.921856	1099.8779	1105.921856	1102.283272	3.321651
Confining pressure (kPa)	50.40293	50.40293	50.40293	50.40293	50.10989	50.344322	0.131052
Maximum axial stress (kPa)	450.21999	450.21999	450.21999	450.21999	450.21999	450.21999	0
Cyclic stress (kPa)	444.001482	442.757781	442.757781	442.757781	442.757781	443.006521	0.5562
Contact stress (kPa)	6.218508	7.46221	7.46221	7.46221	7.46221	7.213469	0.5562
Permanent strain (%)	0.585958	0.585958	0.585958	0.586563	0.585958	0.586079	0.00027
Maximum load (kN)	3.53602	3.53602	3.53602	3.53602	3.53602	3.53602	0
Cyclic load (kN)	3.487179	3.477411	3.477411	3.477411	3.477411	3.479365	0.004368
Contact load (kN)	0.04884	0.058608	0.058608	0.058608	0.058608	0.056654	0.004368
Average resilient def. (mm)	0.219963	0.219976	0.221184	0.219976	0.221184	0.220457	0.000664
Axial 1 resilient def. (mm)	0.215165	0.212747	0.215165	0.212747	0.215165	0.214198	0.001324
Axial 2 resilient def. (mm)	0.224762	0.227204	0.227204	0.227204	0.227204	0.226716	0.001092
Actuator resilient def. (mm)	0.3663	0.3663	0.373626	0.3663	0.3663	0.367766	0.003276
Average permanent def. (mm)	1.171917	1.171917	1.171917	1.173126	1.171917	1.172159	0.000541
Axial 1 permanent def. (mm)	1.163077	1.163077	1.163077	1.165495	1.163077	1.16356	0.001081
Axial 2 permanent def. (mm)	1.180757	1.180757	1.180757	1.180757	1.180757	1.180757	0
Actuator permanent def. (mm)	1.194139	1.194139	1.186813	1.194139	1.194139	1.192674	0.003276
Sequence Number	38						
Cycle Number	496	497	498	499	500	Average	Std Dev.
Resilient Modulus (MPa)	399.272263	403.68252	402.551757	399.272263	400.351777	401.026116	1.999424
Resilient micro-strain	1112.026862	1099.8779	1099.8779	1112.026862	1105.921856	1105.946276	6.074496
Confining pressure (kPa)	50.40293	50.40293	50.695971	50.40293	50.10989	50.40293	0.207211
Maximum axial stress (kPa)	450.21999	450.21999	448.976289	450.21999	448.976289	449.72251	0.681203
Cyclic stress (kPa)	444.001482	444.001482	442.757781	444.001482	442.757781	443.504002	0.681203
Contact stress (kPa)	6.218508	6.218508	6.218508	6.218508	6.218508	6.218508	0
Permanent strain (%)	0.586563	0.586563	0.586563	0.585958	0.585958	0.586321	0.000331
Maximum load (kN)	3.53602	3.53602	3.526252	3.53602	3.526252	3.532112	0.00535
Cyclic load (kN)	3.487179	3.487179	3.477411	3.487179	3.477411	3.483272	0.00535
Contact load (kN)	0.04884	0.04884	0.04884	0.04884	0.04884	0.04884	0
Average resilient def. (mm)	0.222405	0.219976	0.219976	0.222405	0.221184	0.221189	0.001215
Axial 1 resilient def. (mm)	0.215165	0.212747	0.212747	0.215165	0.215165	0.214198	0.001324
Axial 2 resilient def. (mm)	0.229646	0.227204	0.227204	0.229646	0.227204	0.228181	0.001338
Actuator resilient def. (mm)	0.373626	0.3663	0.3663	0.3663	0.3663	0.367766	0.003276
Average permanent def. (mm)	1.173126	1.173126	1.173126	1.171917	1.171917	1.172642	0.000662
Axial 1 permanent def. (mm)	1.165495	1.165495	1.165495	1.163077	1.163077	1.164527	0.001324
Axial 2 permanent def. (mm)	1.180757	1.180757	1.180757	1.180757	1.180757	1.180757	0
Actuator permanent def. (mm)	1.194139	1.194139	1.194139	1.194139	1.194139	1.194139	0
Sequence Number	39						
Cycle Number	496	497	498	499	500	Average	Std Dev.
Resilient Modulus (MPa)	403.704928	404.776048	397.092235	400.329678	398.153854	400.811348	3.362207
Resilient micro-strain	1099.81685	1093.833944	1118.131868	1105.982906	1112.026862	1105.958486	9.614328
Confining pressure (kPa)	50.40293	50.40293	50.10989	50.40293	50.40293	50.344322	0.131052
Maximum axial stress (kPa)	450.21999	448.976289	450.21999	448.976289	448.976289	449.473769	0.681203
Cyclic stress (kPa)	444.001482	442.757781	444.001482	442.757781	442.757781	443.255261	0.681203
Contact stress (kPa)	6.218508	6.218508	6.218508	6.218508	6.218508	6.218508	0
Permanent strain (%)	0.587784	0.587167	0.586563	0.586563	0.586563	0.586928	0.000545
Maximum load (kN)	3.53602	3.526252	3.53602	3.526252	3.526252	3.530159	0.00535
Cyclic load (kN)	3.487179	3.477411	3.487179	3.477411	3.477411	3.481319	0.00535
Contact load (kN)	0.04884	0.04884	0.04884	0.04884	0.04884	0.04884	0
Average resilient def. (mm)	0.219963	0.218767	0.223626	0.221197	0.222405	0.221192	0.001923
Axial 1 resilient def. (mm)	0.212747	0.21033	0.215165	0.212747	0.215165	0.213231	0.002023
Axial 2 resilient def. (mm)	0.227179	0.227204	0.232088	0.229646	0.229646	0.229153	0.002049
Actuator resilient def. (mm)	0.3663	0.358974	0.380952	0.373626	0.373626	0.370696	0.008353
Average permanent def. (mm)	1.175568	1.174335	1.173126	1.173126	1.173126	1.173856	0.001091
Axial 1 permanent def. (mm)	1.167912	1.167912	1.165495	1.165495	1.165495	1.166462	0.001324
Axial 2 permanent def. (mm)	1.183223	1.180757	1.180757	1.180757	1.180757	1.18125	0.001103
Actuator permanent def. (mm)	1.201465	1.201465	1.194139	1.194139	1.194139	1.19707	0.004013
Sequence Number	40						
Cycle Number	496	497	498	499	500	Average	Std Dev.
Resilient Modulus (MPa)	438.635214	435.355311	430.161023	435.355311	431.128971	434.127166	3.466217
Resilient micro-strain	1233.394383	1245.543346	1257.692308	1245.543346	1257.753358	1247.985348	10.179171
Confining pressure (kPa)	50.40293	50.40293	50.10989	50.695971	50.40293	50.40293	0.207211
Maximum axial stress (kPa)	548.472419	549.716121	549.716121	549.716121	549.716121	549.467381	0.5562
Cyclic stress (kPa)	541.010209	542.253911	541.010209	542.253911	542.253911	541.75643	0.681203
Contact stress (kPa)	7.46221	7.46221	8.705911	7.46221	7.46221	7.71095	0.5562
Permanent strain (%)	0.592656	0.592656	0.592051	0.592656	0.591435	0.592291	0.000545
Maximum load (kN)	4.307692	4.31746	4.31746	4.31746	4.31746	4.315507	0.004368
Cyclic load (kN)	4.249084	4.258852	4.249084	4.258852	4.258852	4.254945	0.00535
Contact load (kN)	0.058608	0.058608	0.068376	0.058608	0.058608	0.060562	0.004368
Average resilient def. (mm)	0.246679	0.249109	0.251538	0.249109	0.251551	0.249597	0.002036

Axial 1 resilient def. (mm)	0.234505	0.236923	0.239341	0.236923	0.239341	0.237407	0.002023
Axial 2 resilient def. (mm)	0.258852	0.261294	0.263736	0.261294	0.263761	0.261788	0.002049
Actuator resilient def. (mm)	0.417582	0.424908	0.424908	0.424908	0.432234	0.424908	0.00518
Average permanent def. (mm)	1.185311	1.185311	1.184103	1.185311	1.182869	1.184581	0.001091
Axial 1 permanent def. (mm)	1.18	1.18	1.177582	1.18	1.177582	1.179033	0.001324
Axial 2 permanent def. (mm)	1.190623	1.190623	1.190623	1.190623	1.188156	1.190129	0.001103
Actuator permanent def. (mm)	1.216117	1.216117	1.216117	1.216117	1.208791	1.214652	0.003276
Sequence Number	41						
Cycle Number	496	497	498	499	500	Average	Std Dev.
Resilient Modulus (MPa)	432.259267	437.521258	433.252966	436.496268	433.252966	434.556545	2.303702
Resilient micro-strain	1251.587302	1239.377289	1251.587302	1239.438339	1251.587302	1246.715507	6.671015
Confining pressure (kPa)	50.40293	50.40293	50.695971	50.10989	50.10989	50.344322	0.245175
Maximum axial stress (kPa)	548.472419	548.472419	549.716121	548.472419	549.716121	548.9699	0.681203
Cyclic stress (kPa)	541.010209	542.253911	542.253911	541.010209	542.253911	541.75643	0.681203
Contact stress (kPa)	7.46221	6.218508	7.46221	7.46221	7.46221	7.213469	0.5562
Permanent strain (%)	0.595696	0.596306	0.595696	0.596306	0.595696	0.59594	0.000334
Maximum load (kN)	4.307692	4.307692	4.31746	4.307692	4.31746	4.3116	0.00535
Cyclic load (kN)	4.249084	4.258852	4.258852	4.249084	4.258852	4.254945	0.00535
Contact load (kN)	0.058608	0.04884	0.058608	0.058608	0.058608	0.056654	0.004368
Average resilient def. (mm)	0.250317	0.247875	0.250317	0.247888	0.250317	0.249343	0.001334
Axial 1 resilient def. (mm)	0.239341	0.239341	0.239341	0.236923	0.239341	0.238857	0.001081
Axial 2 resilient def. (mm)	0.261294	0.25641	0.261294	0.258852	0.261294	0.259829	0.002184
Actuator resilient def. (mm)	0.432234	0.417582	0.432234	0.417582	0.432234	0.426374	0.008025
Average permanent def. (mm)	1.191392	1.192613	1.191392	1.192613	1.191392	1.19188	0.000669
Axial 1 permanent def. (mm)	1.184835	1.184835	1.184835	1.184835	1.184835	1.184835	0
Axial 2 permanent def. (mm)	1.197949	1.200391	1.197949	1.200391	1.197949	1.198926	0.001338
Actuator permanent def. (mm)	1.208791	1.216117	1.208791	1.216117	1.208791	1.211722	0.004013
Sequence Number	42						
Cycle Number	496	497	498	499	500	Average	Std Dev.
Resilient Modulus (MPa)	434.246666	435.376651	434.378081	427.045486	433.252966	432.85997	3.336313
Resilient micro-strain	1251.587302	1245.482295	1245.482295	1269.78022	1251.587302	1252.783883	9.979547
Confining pressure (kPa)	50.40293	50.40293	50.10989	50.40293	50.40293	50.344322	0.131052
Maximum axial stress (kPa)	549.716121	548.472419	548.472419	549.716121	548.472419	548.9699	0.681203
Cyclic stress (kPa)	543.497613	542.253911	541.010209	542.253911	542.253911	542.253911	0.87943
Contact stress (kPa)	6.218508	6.218508	7.46221	7.46221	6.218508	6.715989	0.681203
Permanent strain (%)	0.598126	0.598736	0.598736	0.597521	0.598126	0.598249	0.000509
Maximum load (kN)	4.31746	4.307692	4.307692	4.31746	4.307692	4.3116	0.00535
Cyclic load (kN)	4.26862	4.258852	4.249084	4.258852	4.258852	4.258852	0.006907
Contact load (kN)	0.04884	0.04884	0.058608	0.058608	0.04884	0.052747	0.00535
Average resilient def. (mm)	0.250317	0.249096	0.249096	0.253956	0.250317	0.250557	0.001996
Axial 1 resilient def. (mm)	0.239341	0.239341	0.239341	0.244176	0.239341	0.240308	0.002162
Axial 2 resilient def. (mm)	0.261294	0.258852	0.258852	0.263736	0.261294	0.260806	0.002043
Actuator resilient def. (mm)	0.432234	0.424908	0.417582	0.43956	0.424908	0.427839	0.008353
Average permanent def. (mm)	1.196252	1.197473	1.197473	1.195043	1.196252	1.196498	0.001017
Axial 1 permanent def. (mm)	1.18967	1.18967	1.18967	1.187253	1.18967	1.189187	0.001081
Axial 2 permanent def. (mm)	1.202833	1.205275	1.205275	1.202833	1.202833	1.20381	0.001338
Actuator permanent def. (mm)	1.216117	1.223443	1.223443	1.216117	1.216117	1.219048	0.004013
Sequence Number	43						
Cycle Number	496	497	498	499	500	Average	Std Dev.
Resilient Modulus (MPa)	433.252966	432.159752	432.259267	437.499708	431.265567	433.287452	2.457701
Resilient micro-strain	1251.587302	1257.631258	1251.587302	1239.438339	1251.587302	1250.3663	6.64591
Confining pressure (kPa)	50.695971	50.40293	50.40293	50.40293	50.40293	50.461538	0.131052
Maximum axial stress (kPa)	548.472419	549.716121	548.472419	549.716121	548.472419	548.9699	0.681203
Cyclic stress (kPa)	542.253911	543.497613	541.010209	542.253911	539.766508	541.75643	1.418038
Contact stress (kPa)	6.218508	6.218508	7.46221	7.46221	8.705911	7.213469	1.040555
Permanent strain (%)	0.600556	0.600556	0.600556	0.60177	0.600556	0.600799	0.000543
Maximum load (kN)	4.307692	4.31746	4.307692	4.31746	4.307692	4.3116	0.00535
Cyclic load (kN)	4.258852	4.26862	4.249084	4.258852	4.239316	4.254945	0.011137
Contact load (kN)	0.04884	0.04884	0.058608	0.058608	0.068376	0.056654	0.008173
Average resilient def. (mm)	0.250317	0.251526	0.250317	0.247888	0.250317	0.250073	0.001329
Axial 1 resilient def. (mm)	0.239341	0.241758	0.239341	0.236923	0.239341	0.239341	0.001709
Axial 2 resilient def. (mm)	0.261294	0.261294	0.261294	0.258852	0.261294	0.260806	0.001092
Actuator resilient def. (mm)	0.424908	0.424908	0.424908	0.424908	0.424908	0.424908	0
Average permanent def. (mm)	1.201111	1.201111	1.201111	1.203541	1.201111	1.201597	0.001087
Axial 1 permanent def. (mm)	1.194505	1.194505	1.194505	1.196923	1.194505	1.194989	0.001081
Axial 2 permanent def. (mm)	1.207717	1.207717	1.207717	1.210159	1.207717	1.208205	0.001092
Actuator permanent def. (mm)	1.230769	1.230769	1.230769	1.230769	1.230769	1.230769	0
Sequence Number	44						
Cycle Number	496	497	498	499	500	Average	Std Dev.
Resilient Modulus (MPa)	432.259267	433.252966	433.252966	429.087877	434.246666	432.419949	1.990807
Resilient micro-strain	1251.587302	1251.587302	1251.587302	1263.736264	1251.587302	1254.017094	5.433181
Confining pressure (kPa)	50.40293	50.40293	50.695971	50.40293	50.10989	50.40293	0.207211
Maximum axial stress (kPa)	548.472419	549.716121	549.716121	549.716121	549.716121	549.467381	0.5562
Cyclic stress (kPa)	541.010209	542.253911	542.253911	542.253911	543.497613	542.253911	0.87943
Contact stress (kPa)	7.46221	7.46221	7.46221	7.46221	6.218508	7.213469	0.5562
Permanent strain (%)	0.602985	0.602985	0.602985	0.602381	0.602985	0.602864	0.00027
Maximum load (kN)	4.307692	4.31746	4.31746	4.31746	4.31746	4.315507	0.004368

Appendix C: Red Sand Stabilisation

Cyclic load (kN)	4.249084	4.258852	4.258852	4.258852	4.26862	4.258852	0.006907
Contact load (kN)	0.058608	0.058608	0.058608	0.058608	0.04884	0.056654	0.004368
Average resilient def. (mm)	0.250317	0.250317	0.250317	0.252747	0.250317	0.250803	0.001087
Axial 1 resilient def. (mm)	0.239341	0.239341	0.239341	0.241758	0.239341	0.239824	0.001081
Axial 2 resilient def. (mm)	0.261294	0.261294	0.261294	0.263736	0.261294	0.261783	0.001092
Actuator resilient def. (mm)	0.424908	0.424908	0.424908	0.432234	0.417582	0.424908	0.00518
Average permanent def. (mm)	1.205971	1.205971	1.205971	1.204762	1.205971	1.205729	0.000541
Axial 1 permanent def. (mm)	1.199341	1.199341	1.199341	1.196923	1.199341	1.198857	0.001081
Axial 2 permanent def. (mm)	1.212601	1.212601	1.212601	1.212601	1.212601	1.212601	0
Actuator permanent def. (mm)	1.230769	1.238095	1.238095	1.230769	1.238095	1.235165	0.004013
Sequence Number	45						
Cycle Number	496	497	498	499	500	Average	Std Dev.
Resilient Modulus (MPa)	435.397993	435.376651	436.496268	434.378081	435.376651	435.405129	0.749514
Resilient micro-strain	1245.421245	1245.482295	1239.438339	1245.482295	1245.482295	1244.261294	2.696243
Confining pressure (kPa)	50.40293	50.40293	50.40293	50.695971	50.695971	50.520147	0.160505
Maximum axial stress (kPa)	549.716121	549.716121	548.472419	548.472419	549.716121	549.21864	0.681203
Cyclic stress (kPa)	542.253911	542.253911	541.010209	541.010209	542.253911	541.75643	0.681203
Contact stress (kPa)	7.46221	7.46221	7.46221	7.46221	7.46221	7.46221	0
Permanent strain (%)	0.605421	0.606026	0.606026	0.606026	0.604811	0.605662	0.000543
Maximum load (kN)	4.31746	4.31746	4.307692	4.307692	4.31746	4.313553	0.00535
Cyclic load (kN)	4.258852	4.258852	4.249084	4.249084	4.258852	4.254945	0.00535
Contact load (kN)	0.058608	0.058608	0.058608	0.058608	0.058608	0.058608	0
Average resilient def. (mm)	0.249084	0.249096	0.247888	0.249096	0.249096	0.248852	0.000539
Axial 1 resilient def. (mm)	0.241758	0.239341	0.236923	0.239341	0.239341	0.239341	0.001709
Axial 2 resilient def. (mm)	0.25641	0.258852	0.258852	0.258852	0.258852	0.258364	0.001092
Actuator resilient def. (mm)	0.424908	0.417582	0.424908	0.424908	0.424908	0.423443	0.003276
Average permanent def. (mm)	1.210842	1.212051	1.212051	1.212051	1.209621	1.211324	0.001086
Axial 1 permanent def. (mm)	1.201758	1.204176	1.204176	1.204176	1.201758	1.203209	0.001324
Axial 2 permanent def. (mm)	1.219927	1.219927	1.219927	1.219927	1.217485	1.219438	0.001092
Actuator permanent def. (mm)	1.230769	1.238095	1.230769	1.230769	1.230769	1.232234	0.003276
Sequence Number	46						
Cycle Number	496	497	498	499	500	Average	Std Dev.
Resilient Modulus (MPa)	435.376651	434.378081	436.496268	434.378081	432.159752	434.557767	1.600266
Resilient micro-strain	1245.482295	1245.482295	1239.438339	1245.482295	1257.631258	1246.703297	6.64591
Confining pressure (kPa)	50.40293	50.40293	50.40293	50.695971	50.10989	50.40293	0.207211
Maximum axial stress (kPa)	549.716121	548.472419	548.472419	548.472419	549.716121	548.9699	0.681203
Cyclic stress (kPa)	542.253911	541.010209	541.010209	541.010209	543.497613	541.75643	1.112401
Contact stress (kPa)	7.46221	7.46221	7.46221	7.46221	6.218508	7.213469	0.5562
Permanent strain (%)	0.607241	0.607241	0.607241	0.607241	0.607241	0.607241	0
Maximum load (kN)	4.31746	4.307692	4.307692	4.307692	4.31746	4.3116	0.00535
Cyclic load (kN)	4.258852	4.249084	4.249084	4.249084	4.26862	4.254945	0.008737
Contact load (kN)	0.058608	0.058608	0.058608	0.058608	0.04884	0.056654	0.004368
Average resilient def. (mm)	0.249096	0.249096	0.247888	0.249096	0.251526	0.249341	0.001329
Axial 1 resilient def. (mm)	0.239341	0.239341	0.236923	0.239341	0.241758	0.239341	0.001709
Axial 2 resilient def. (mm)	0.258852	0.258852	0.258852	0.258852	0.261294	0.259341	0.001092
Actuator resilient def. (mm)	0.424908	0.424908	0.424908	0.424908	0.424908	0.424908	0
Average permanent def. (mm)	1.214481	1.214481	1.214481	1.214481	1.214481	1.214481	0
Axial 1 permanent def. (mm)	1.206593	1.206593	1.206593	1.206593	1.206593	1.206593	0
Axial 2 permanent def. (mm)	1.222369	1.222369	1.222369	1.222369	1.222369	1.222369	0
Actuator permanent def. (mm)	1.238095	1.238095	1.238095	1.238095	1.238095	1.238095	0
Sequence Number	47						
Cycle Number	496	497	498	499	500	Average	Std Dev.
Resilient Modulus (MPa)	436.496268	437.499708	434.35679	434.246666	434.378081	435.395503	1.506093
Resilient micro-strain	1239.438339	1239.438339	1245.543346	1251.587302	1245.482295	1244.297924	5.082321
Confining pressure (kPa)	50.695971	50.40293	50.40293	50.695971	50.40293	50.520147	0.160505
Maximum axial stress (kPa)	548.472419	549.716121	548.472419	549.716121	548.472419	548.9699	0.681203
Cyclic stress (kPa)	541.010209	542.253911	541.010209	543.497613	541.010209	541.75643	1.112401
Contact stress (kPa)	7.46221	7.46221	7.46221	6.218508	7.46221	7.213469	0.5562
Permanent strain (%)	0.60906	0.60967	0.60906	0.60906	0.60967	0.609304	0.000334
Maximum load (kN)	4.307692	4.31746	4.307692	4.31746	4.307692	4.3116	0.00535
Cyclic load (kN)	4.249084	4.258852	4.249084	4.26862	4.249084	4.254945	0.008737
Contact load (kN)	0.058608	0.058608	0.058608	0.04884	0.058608	0.056654	0.004368
Average resilient def. (mm)	0.247888	0.247888	0.249109	0.250317	0.249096	0.24886	0.001016
Axial 1 resilient def. (mm)	0.236923	0.236923	0.236923	0.239341	0.239341	0.23789	0.001324
Axial 2 resilient def. (mm)	0.258852	0.258852	0.261294	0.261294	0.258852	0.259829	0.001338
Actuator resilient def. (mm)	0.424908	0.424908	0.424908	0.424908	0.424908	0.424908	0
Average permanent def. (mm)	1.21812	1.219341	1.21812	1.21812	1.219341	1.218608	0.000669
Axial 1 permanent def. (mm)	1.211429	1.211429	1.211429	1.211429	1.211429	1.211429	0
Axial 2 permanent def. (mm)	1.224811	1.227253	1.224811	1.224811	1.227253	1.225788	0.001338
Actuator permanent def. (mm)	1.245421	1.252747	1.245421	1.245421	1.245421	1.246886	0.003276
Sequence Number	48						
Cycle Number	496	497	498	499	500	Average	Std Dev.
Resilient Modulus (MPa)	435.376651	432.138775	434.378081	435.376651	435.376651	434.529362	1.40459
Resilient micro-strain	1245.482295	1257.692308	1245.482295	1245.482295	1245.482295	1247.924298	5.460483
Confining pressure (kPa)	50.40293	50.40293	50.40293	50.40293	50.40293	50.40293	0
Maximum axial stress (kPa)	549.716121	550.959823	548.472419	549.716121	548.472419	549.467381	1.040555
Cyclic stress (kPa)	542.253911	543.497613	541.010209	542.253911	542.253911	542.253911	0.87943

Contact stress (kPa)	7.46221	7.46221	7.46221	7.46221	6.218508	7.213469	0.5562
Permanent strain (%)	0.610885	0.61149	0.610885	0.610885	0.610885	0.611006	0.00027
Maximum load (kN)	4.31746	4.327228	4.307692	4.31746	4.307692	4.315507	0.008173
Cyclic load (kN)	4.258852	4.26862	4.249084	4.258852	4.258852	4.258852	0.006907
Contact load (kN)	0.058608	0.058608	0.058608	0.058608	0.04884	0.056654	0.004368
Average resilient def. (mm)	0.249096	0.251538	0.249096	0.249096	0.249096	0.249585	0.001092
Axial 1 resilient def. (mm)	0.239341	0.239341	0.239341	0.239341	0.239341	0.239341	0
Axial 2 resilient def. (mm)	0.258852	0.263736	0.258852	0.258852	0.258852	0.259829	0.002184
Actuator resilient def. (mm)	0.424908	0.432234	0.417582	0.432234	0.424908	0.426374	0.006129
Average permanent def. (mm)	1.22177	1.222979	1.22177	1.22177	1.22177	1.222012	0.000541
Axial 1 permanent def. (mm)	1.213846	1.216264	1.213846	1.213846	1.213846	1.21433	0.001081
Axial 2 permanent def. (mm)	1.229695	1.229695	1.229695	1.229695	1.229695	1.229695	0
Actuator permanent def. (mm)	1.252747	1.252747	1.252747	1.245421	1.252747	1.251282	0.003276
Sequence Number	49						
Cycle Number	496	497	498	499	500	Average	Std Dev.
Resilient Modulus (MPa)	437.521258	438.524747	436.375222	439.665333	438.656927	438.148697	1.248879
Resilient micro-strain	1239.377289	1239.377289	1245.482295	1233.333333	1233.333333	1238.180708	5.078653
Confining pressure (kPa)	50.40293	50.40293	50.40293	50.40293	50.40293	50.40293	0
Maximum axial stress (kPa)	549.716121	550.959823	549.716121	549.716121	548.472419	549.716121	0.87943
Cyclic stress (kPa)	542.253911	543.497613	543.497613	542.253911	541.010209	542.502651	1.040555
Contact stress (kPa)	7.46221	7.46221	6.218508	7.46221	7.46221	7.213469	0.5562
Permanent strain (%)	0.613315	0.613315	0.613315	0.613315	0.613315	0.613315	0
Maximum load (kN)	4.31746	4.327228	4.31746	4.31746	4.307692	4.31746	0.006907
Cyclic load (kN)	4.258852	4.26862	4.26862	4.258852	4.249084	4.260806	0.008173
Contact load (kN)	0.058608	0.058608	0.04884	0.058608	0.058608	0.056654	0.004368
Average resilient def. (mm)	0.247875	0.247875	0.249096	0.246667	0.246667	0.247636	0.001016
Axial 1 resilient def. (mm)	0.239341	0.239341	0.239341	0.236923	0.236923	0.238374	0.001324
Axial 2 resilient def. (mm)	0.25641	0.25641	0.258852	0.25641	0.25641	0.256899	0.001092
Actuator resilient def. (mm)	0.424908	0.432234	0.424908	0.424908	0.417582	0.424908	0.00518
Average permanent def. (mm)	1.22663	1.22663	1.22663	1.22663	1.22663	1.22663	0
Axial 1 permanent def. (mm)	1.218681	1.218681	1.218681	1.218681	1.218681	1.218681	0
Axial 2 permanent def. (mm)	1.234579	1.234579	1.234579	1.234579	1.234579	1.234579	0
Actuator permanent def. (mm)	1.252747	1.245421	1.252747	1.245421	1.252747	1.249817	0.004013
Sequence Number	50						
Cycle Number	496	497	498	499	500	Average	Std Dev.
Resilient Modulus (MPa)	440.839082	438.656927	436.375222	438.656927	438.656927	438.637017	1.578449
Resilient micro-strain	1227.228327	1233.333333	1245.482295	1233.333333	1233.333333	1234.542125	6.662629
Confining pressure (kPa)	50.695971	50.40293	50.695971	50.695971	50.40293	50.578755	0.160505
Maximum axial stress (kPa)	548.472419	548.472419	549.716121	548.472419	548.472419	548.72116	0.5562
Cyclic stress (kPa)	541.010209	541.010209	543.497613	541.010209	541.010209	541.50769	1.112401
Contact stress (kPa)	7.46221	7.46221	6.218508	7.46221	7.46221	7.213469	0.5562
Permanent strain (%)	0.61514	0.61453	0.61453	0.61453	0.61453	0.614652	0.000273
Maximum load (kN)	4.307692	4.307692	4.31746	4.307692	4.307692	4.309646	0.004368
Cyclic load (kN)	4.249084	4.249084	4.26862	4.249084	4.249084	4.252991	0.008737
Contact load (kN)	0.058608	0.058608	0.04884	0.058608	0.058608	0.056654	0.004368
Average resilient def. (mm)	0.245446	0.246667	0.249096	0.246667	0.246667	0.246908	0.001333
Axial 1 resilient def. (mm)	0.236923	0.236923	0.239341	0.236923	0.236923	0.237407	0.001081
Axial 2 resilient def. (mm)	0.253968	0.25641	0.258852	0.25641	0.25641	0.25641	0.001727
Actuator resilient def. (mm)	0.424908	0.424908	0.424908	0.424908	0.424908	0.424908	0
Average permanent def. (mm)	1.230281	1.22906	1.22906	1.22906	1.22906	1.229304	0.000546
Axial 1 permanent def. (mm)	1.221099	1.221099	1.221099	1.221099	1.221099	1.221099	0
Axial 2 permanent def. (mm)	1.239463	1.237021	1.237021	1.237021	1.237021	1.237509	0.001092
Actuator permanent def. (mm)	1.252747	1.252747	1.252747	1.252747	1.252747	1.252747	0
Sequence Number	51						
Cycle Number	496	497	498	499	500	Average	Std Dev.
Resilient Modulus (MPa)	435.376651	438.524747	436.496268	439.665333	438.524747	437.717549	1.736975
Resilient micro-strain	1245.482295	1239.377289	1239.438339	1233.333333	1239.377289	1239.401709	4.295383
Confining pressure (kPa)	50.40293	50.40293	50.10989	50.40293	50.40293	50.344322	0.131052
Maximum axial stress (kPa)	549.716121	549.716121	548.472419	548.472419	549.716121	549.21864	0.681203
Cyclic stress (kPa)	542.253911	543.497613	541.010209	542.253911	543.497613	542.502651	1.040555
Contact stress (kPa)	7.46221	6.218508	7.46221	6.218508	6.218508	6.715989	0.681203
Permanent strain (%)	0.615745	0.615745	0.615745	0.615745	0.615745	0.615745	0
Maximum load (kN)	4.31746	4.31746	4.307692	4.307692	4.31746	4.313553	0.00535
Cyclic load (kN)	4.258852	4.26862	4.249084	4.258852	4.26862	4.260806	0.008173
Contact load (kN)	0.058608	0.04884	0.058608	0.04884	0.04884	0.052747	0.00535
Average resilient def. (mm)	0.249096	0.247875	0.247888	0.246667	0.247875	0.24788	0.000859
Axial 1 resilient def. (mm)	0.239341	0.239341	0.236923	0.236923	0.239341	0.238374	0.001324
Axial 2 resilient def. (mm)	0.258852	0.25641	0.258852	0.25641	0.25641	0.257387	0.001338
Actuator resilient def. (mm)	0.424908	0.424908	0.424908	0.417582	0.424908	0.423443	0.003276
Average permanent def. (mm)	1.23149	1.23149	1.23149	1.23149	1.23149	1.23149	0
Axial 1 permanent def. (mm)	1.223516	1.223516	1.223516	1.223516	1.223516	1.223516	0
Axial 2 permanent def. (mm)	1.239463	1.239463	1.239463	1.239463	1.239463	1.239463	0
Actuator permanent def. (mm)	1.260073	1.260073	1.260073	1.260073	1.260073	1.260073	0
Sequence Number	52						
Cycle Number	496	497	498	499	500	Average	Std Dev.
Resilient Modulus (MPa)	440.67374	445.080037	443.020908	441.852505	437.521258	441.62969	2.814386
Resilient micro-strain	1233.333333	1221.123321	1221.184371	1227.228327	1239.377289	1228.449328	7.924876

Confining pressure (kPa)	50.40293	50.10989	50.40293	50.40293	50.40293	50.344322	0.131052
Maximum axial stress (kPa)	549.716121	549.716121	548.472419	549.716121	549.716121	549.467381	0.5562
Cyclic stress (kPa)	543.497613	543.497613	541.010209	542.253911	542.253911	542.502651	1.040555
Contact stress (kPa)	6.218508	6.218508	7.46221	7.46221	7.46221	6.964729	0.681203
Permanent strain (%)	0.61757	0.618785	0.618175	0.618785	0.61757	0.618177	0.000607
Maximum load (kN)	4.31746	4.31746	4.307692	4.31746	4.31746	4.315507	0.004368
Cyclic load (kN)	4.26862	4.26862	4.249084	4.258852	4.258852	4.260806	0.008173
Contact load (kN)	0.04884	0.04884	0.058608	0.058608	0.058608	0.054701	0.00535
Average resilient def. (mm)	0.246667	0.244225	0.244237	0.245446	0.247875	0.24569	0.001585
Axial 1 resilient def. (mm)	0.236923	0.236923	0.234505	0.236923	0.239341	0.236923	0.001709
Axial 2 resilient def. (mm)	0.25641	0.251526	0.253968	0.253968	0.25641	0.254457	0.002043
Actuator resilient def. (mm)	0.424908	0.424908	0.424908	0.424908	0.424908	0.424908	0
Average permanent def. (mm)	1.23514	1.23757	1.236349	1.23757	1.23514	1.236354	0.001215
Axial 1 permanent def. (mm)	1.225934	1.228352	1.228352	1.228352	1.225934	1.227385	0.001324
Axial 2 permanent def. (mm)	1.244347	1.246789	1.244347	1.246789	1.244347	1.245324	0.001338
Actuator permanent def. (mm)	1.260073	1.260073	1.260073	1.260073	1.260073	1.260073	0
Sequence Number	53						
Cycle Number	496	497	498	499	500	Average	Std Dev.
Resilient Modulus (MPa)	444.039347	443.020908	444.039347	446.270364	441.852505	443.844495	1.628427
Resilient micro-strain	1221.184371	1221.184371	1221.184371	1215.079365	1227.228327	1221.172161	4.295339
Confining pressure (kPa)	50.40293	50.40293	50.40293	50.40293	50.40293	50.40293	0
Maximum axial stress (kPa)	549.716121	548.472419	548.472419	549.716121	549.716121	549.21864	0.681203
Cyclic stress (kPa)	542.253911	541.010209	542.253911	542.253911	542.253911	542.005171	0.5562
Contact stress (kPa)	7.46221	7.46221	6.218508	7.46221	7.46221	7.213469	0.5562
Permanent strain (%)	0.619389	0.619389	0.62	0.62	0.618785	0.619513	0.000509
Maximum load (kN)	4.31746	4.307692	4.307692	4.31746	4.31746	4.313553	0.00535
Cyclic load (kN)	4.258852	4.249084	4.258852	4.258852	4.258852	4.256899	0.004368
Contact load (kN)	0.058608	0.058608	0.04884	0.058608	0.058608	0.056654	0.004368
Average resilient def. (mm)	0.244237	0.244237	0.244237	0.243016	0.245446	0.244234	0.000859
Axial 1 resilient def. (mm)	0.234505	0.234505	0.234505	0.234505	0.236923	0.234989	0.001081
Axial 2 resilient def. (mm)	0.253968	0.253968	0.253968	0.251526	0.253968	0.25348	0.001092
Actuator resilient def. (mm)	0.417582	0.424908	0.417582	0.417582	0.424908	0.420513	0.004013
Average permanent def. (mm)	1.238779	1.238779	1.24	1.24	1.23757	1.239026	0.001017
Axial 1 permanent def. (mm)	1.230769	1.230769	1.230769	1.230769	1.228352	1.230286	0.001081
Axial 2 permanent def. (mm)	1.246789	1.246789	1.249231	1.249231	1.246789	1.247766	0.001338
Actuator permanent def. (mm)	1.267399	1.260073	1.267399	1.267399	1.260073	1.264469	0.004013
Sequence Number	54						
Cycle Number	496	497	498	499	500	Average	Std Dev.
Resilient Modulus (MPa)	438.635214	443.020908	439.621811	439.643571	439.643571	440.113015	1.682392
Resilient micro-strain	1233.394383	1221.184371	1233.455433	1233.394383	1233.394383	1230.964591	5.467373
Confining pressure (kPa)	50.40293	50.695971	50.10989	50.695971	50.40293	50.461538	0.245175
Maximum axial stress (kPa)	548.472419	548.472419	549.716121	549.716121	548.472419	548.9699	0.681203
Cyclic stress (kPa)	541.010209	541.010209	542.253911	542.253911	542.253911	541.75643	0.681203
Contact stress (kPa)	7.46221	7.46221	7.46221	7.46221	6.218508	7.213469	0.5562
Permanent strain (%)	0.621215	0.620604	0.621819	0.620604	0.620604	0.620969	0.000544
Maximum load (kN)	4.307692	4.307692	4.31746	4.31746	4.307692	4.3116	0.00535
Cyclic load (kN)	4.249084	4.249084	4.258852	4.258852	4.258852	4.254945	0.00535
Contact load (kN)	0.058608	0.058608	0.058608	0.058608	0.04884	0.056654	0.004368
Average resilient def. (mm)	0.246679	0.244237	0.246691	0.246679	0.246679	0.246193	0.001093
Axial 1 resilient def. (mm)	0.239389	0.234505	0.236972	0.236947	0.236947	0.236952	0.001727
Axial 2 resilient def. (mm)	0.253968	0.253968	0.25641	0.25641	0.25641	0.255433	0.001338
Actuator resilient def. (mm)	0.432234	0.424908	0.417582	0.424908	0.417582	0.423443	0.006129
Average permanent def. (mm)	1.24243	1.241209	1.243639	1.241209	1.241209	1.241939	0.001087
Axial 1 permanent def. (mm)	1.233187	1.233187	1.235604	1.233187	1.233187	1.23367	0.001081
Axial 2 permanent def. (mm)	1.251673	1.249231	1.251673	1.249231	1.249231	1.250208	0.001338
Actuator permanent def. (mm)	1.267399	1.267399	1.274725	1.267399	1.274725	1.27033	0.004013
Sequence Number	55						
Cycle Number	496	497	498	499	500	Average	Std Dev.
Resilient Modulus (MPa)	443.994954	439.600053	441.786574	443.994954	442.976617	442.470631	1.844675
Resilient micro-strain	1221.306471	1233.516484	1227.411477	1221.306471	1221.306471	1224.969475	5.460483
Confining pressure (kPa)	50.695971	50.10989	50.40293	50.40293	50.40293	50.40293	0.207211
Maximum axial stress (kPa)	549.716121	549.716121	549.716121	548.472419	548.472419	549.21864	0.681203
Cyclic stress (kPa)	542.253911	542.253911	542.253911	542.253911	541.010209	542.005171	0.5562
Contact stress (kPa)	7.46221	7.46221	7.46221	6.218508	7.46221	7.213469	0.5562
Permanent strain (%)	0.623034	0.623034	0.622424	0.623034	0.623034	0.622912	0.000273
Maximum load (kN)	4.31746	4.31746	4.31746	4.307692	4.307692	4.313553	0.00535
Cyclic load (kN)	4.258852	4.258852	4.258852	4.258852	4.249084	4.256899	0.004368
Contact load (kN)	0.058608	0.058608	0.058608	0.04884	0.058608	0.056654	0.004368
Average resilient def. (mm)	0.244261	0.246703	0.245482	0.244261	0.244261	0.244994	0.001092
Axial 1 resilient def. (mm)	0.234554	0.236996	0.234554	0.234554	0.234554	0.235043	0.001092
Axial 2 resilient def. (mm)	0.253968	0.25641	0.25641	0.253968	0.253968	0.254945	0.001338
Actuator resilient def. (mm)	0.424908	0.417582	0.424908	0.417582	0.417582	0.420513	0.004013
Average permanent def. (mm)	1.246068	1.246068	1.244847	1.246068	1.246068	1.245824	0.000546
Axial 1 permanent def. (mm)	1.238022	1.238022	1.238022	1.238022	1.238022	1.238022	0
Axial 2 permanent def. (mm)	1.254115	1.254115	1.251673	1.254115	1.254115	1.253626	0.001092
Actuator permanent def. (mm)	1.282051	1.282051	1.274725	1.282051	1.282051	1.280586	0.003276
Sequence Number	56						
Cycle Number	496	497	498	499	500	Average	Std Dev.

Resilient Modulus (MPa)	449.675102	449.675102	446.180693	450.708838	451.742574	449.596462	2.093025
Resilient micro-strain	1203.113553	1203.113553	1215.323565	1203.113553	1203.113553	1205.555556	5.460483
Confining pressure (kPa)	50.40293	50.40293	49.81685	50.10989	50.40293	50.227106	0.262103
Maximum axial stress (kPa)	548.472419	548.472419	549.716121	548.472419	549.716121	548.9699	0.681203
Cyclic stress (kPa)	541.010209	541.010209	542.253911	542.253911	543.497613	542.005171	1.040555
Contact stress (kPa)	7.46221	7.46221	7.46221	6.218508	6.218508	6.964729	0.681203
Permanent strain (%)	0.626074	0.626074	0.625464	0.626074	0.626074	0.625952	0.000273
Maximum load (kN)	4.307692	4.307692	4.31746	4.307692	4.31746	4.3116	0.00535
Cyclic load (kN)	4.249084	4.249084	4.258852	4.258852	4.26862	4.256899	0.008173
Contact load (kN)	0.058608	0.058608	0.058608	0.04884	0.04884	0.054701	0.00535
Average resilient def. (mm)	0.240623	0.240623	0.243065	0.240623	0.240623	0.241111	0.001092
Axial 1 resilient def. (mm)	0.232161	0.232161	0.234603	0.232161	0.232161	0.23265	0.001092
Axial 2 resilient def. (mm)	0.249084	0.249084	0.251526	0.249084	0.249084	0.249573	0.001092
Actuator resilient def. (mm)	0.417582	0.417582	0.417582	0.417582	0.417582	0.417582	0
Average permanent def. (mm)	1.252149	1.252149	1.250928	1.252149	1.252149	1.251905	0.000546
Axial 1 permanent def. (mm)	1.242857	1.242857	1.242857	1.242857	1.242857	1.242857	0
Axial 2 permanent def. (mm)	1.261441	1.261441	1.258999	1.261441	1.261441	1.260952	0.001092
Actuator permanent def. (mm)	1.274725	1.274725	1.274725	1.274725	1.274725	1.274725	0
Sequence Number	57						
Cycle Number	496	497	498	499	500	Average	Std Dev.
Resilient Modulus (MPa)	448.410696	442.711766	454.215645	449.62947	444.946566	447.982829	4.436933
Resilient micro-strain	1209.279609	1227.655678	1191.086691	1203.235653	1221.489621	1210.549451	14.544874
Confining pressure (kPa)	50.40293	50.40293	50.695971	50.40293	50.40293	50.461538	0.131052
Maximum axial stress (kPa)	549.716121	549.716121	549.716121	549.716121	550.959823	549.964861	0.5562
Cyclic stress (kPa)	542.253911	543.497613	541.010209	541.010209	543.497613	542.253911	1.243702
Contact stress (kPa)	7.46221	6.218508	8.705911	8.705911	7.46221	7.71095	1.040555
Permanent strain (%)	0.627289	0.627894	0.629109	0.627894	0.627289	0.627895	0.000743
Maximum load (kN)	4.31746	4.31746	4.31746	4.31746	4.327228	4.319414	0.004368
Cyclic load (kN)	4.258852	4.26862	4.249084	4.249084	4.26862	4.258852	0.009768
Contact load (kN)	0.058608	0.04884	0.068376	0.068376	0.058608	0.060562	0.008173
Average resilient def. (mm)	0.241856	0.245531	0.238217	0.240647	0.244298	0.24211	0.002909
Axial 1 resilient def. (mm)	0.234628	0.237094	0.229792	0.23221	0.23707	0.234159	0.003169
Axial 2 resilient def. (mm)	0.249084	0.253968	0.246642	0.249084	0.251526	0.250061	0.002784
Actuator resilient def. (mm)	0.417582	0.424908	0.410256	0.410256	0.424908	0.417582	0.007326
Average permanent def. (mm)	1.254579	1.255788	1.258217	1.255788	1.254579	1.25579	0.001485
Axial 1 permanent def. (mm)	1.245275	1.247692	1.25011	1.247692	1.245275	1.247209	0.002023
Axial 2 permanent def. (mm)	1.263883	1.263883	1.266325	1.263883	1.263883	1.264371	0.001092
Actuator permanent def. (mm)	1.282051	1.289377	1.289377	1.289377	1.282051	1.286447	0.004013
Sequence Number	58						
Cycle Number	496	497	498	499	500	Average	Std Dev.
Resilient Modulus (MPa)	448.365425	450.640237	443.906195	448.159856	444.902094	447.194761	2.749734
Resilient micro-strain	1209.401709	1203.296703	1221.550672	1215.506716	1221.611722	1214.273504	7.945942
Confining pressure (kPa)	50.695971	50.40293	50.40293	50.40293	50.40293	50.461538	0.131052
Maximum axial stress (kPa)	549.716121	549.716121	548.472419	550.959823	550.959823	549.964861	1.040555
Cyclic stress (kPa)	542.253911	542.253911	542.253911	544.741314	543.497613	543.000132	1.112401
Contact stress (kPa)	7.46221	7.46221	6.218508	6.218508	7.46221	6.964729	0.681203
Permanent strain (%)	0.629109	0.629109	0.628504	0.629109	0.629109	0.628988	0.00027
Maximum load (kN)	4.31746	4.31746	4.307692	4.327228	4.327228	4.319414	0.008173
Cyclic load (kN)	4.258852	4.258852	4.258852	4.278388	4.26862	4.264713	0.008737
Contact load (kN)	0.058608	0.058608	0.04884	0.04884	0.058608	0.054701	0.00535
Average resilient def. (mm)	0.24188	0.240659	0.24431	0.243101	0.244322	0.242855	0.001589
Axial 1 resilient def. (mm)	0.232234	0.232234	0.237094	0.234676	0.234676	0.234183	0.002034
Axial 2 resilient def. (mm)	0.251526	0.249084	0.251526	0.251526	0.253968	0.251526	0.001727
Actuator resilient def. (mm)	0.417582	0.417582	0.417582	0.417582	0.424908	0.419048	0.003276
Average permanent def. (mm)	1.258217	1.258217	1.257009	1.258217	1.258217	1.257976	0.000541
Axial 1 permanent def. (mm)	1.25011	1.25011	1.247692	1.25011	1.25011	1.249626	0.001081
Axial 2 permanent def. (mm)	1.266325	1.266325	1.266325	1.266325	1.266325	1.266325	0
Actuator permanent def. (mm)	1.289377	1.289377	1.289377	1.289377	1.289377	1.289377	0
Sequence Number	59						
Cycle Number	496	497	498	499	500	Average	Std Dev.
Resilient Modulus (MPa)	447.314483	445.067914	444.879861	449.371102	443.861829	446.099038	2.221397
Resilient micro-strain	1209.462759	1215.567766	1221.672772	1209.462759	1221.672772	1215.567766	6.105006
Confining pressure (kPa)	50.40293	50.40293	50.695971	50.10989	50.10989	50.344322	0.245175
Maximum axial stress (kPa)	548.472419	548.472419	550.959823	549.716121	549.716121	549.467381	1.040555
Cyclic stress (kPa)	541.010209	541.010209	543.497613	543.497613	542.253911	542.253911	1.243702
Contact stress (kPa)	7.46221	7.46221	7.46221	6.218508	7.46221	7.213469	0.5562
Permanent strain (%)	0.630324	0.630324	0.630324	0.630324	0.630324	0.630324	0
Maximum load (kN)	4.307692	4.307692	4.327228	4.31746	4.31746	4.315507	0.008173
Cyclic load (kN)	4.249084	4.249084	4.26862	4.26862	4.258852	4.258852	0.009768
Contact load (kN)	0.058608	0.058608	0.058608	0.04884	0.058608	0.056654	0.004368
Average resilient def. (mm)	0.241893	0.243114	0.244335	0.241893	0.244335	0.243114	0.001221
Axial 1 resilient def. (mm)	0.232259	0.234701	0.234701	0.232259	0.234701	0.233724	0.001338
Axial 2 resilient def. (mm)	0.251526	0.251526	0.253968	0.251526	0.253968	0.252503	0.001338
Actuator resilient def. (mm)	0.417582	0.417582	0.424908	0.417582	0.424908	0.420513	0.004013
Average permanent def. (mm)	1.260647	1.260647	1.260647	1.260647	1.260647	1.260647	0
Axial 1 permanent def. (mm)	1.252527	1.252527	1.252527	1.252527	1.252527	1.252527	0
Axial 2 permanent def. (mm)	1.268767	1.268767	1.268767	1.268767	1.268767	1.268767	0
Actuator permanent def. (mm)	1.296703	1.296703	1.296703	1.296703	1.296703	1.296703	0

Appendix C: Red Sand Stabilisation

HCTCRB

IPC Global Universal Testing Machine							
UTM_41 V2.01 Resilient Modulus Test							
Filename	D:\my research\Lab test Data\Resilient Modulus\Permanent deformation\						
Operator	Peerapong Jitsangiam						
Test method	Non Standard Testing						
Notes/Comments	ths test follows the standard of Ausroads (APRG 00/33(MA)) for a permanent deformation						
Specimen Information							
********************							
Identification	HCTCRB						
Core/Sample Number	1						
Dimensions	Point 1	Point 2	Point 3	Point 4	Point 5	Average	Std Dev.
Diameter (mm)	100					100	
Height (mm)	200					200	
Cross-Sectional area	7853.982						
Volume	1570796						
Comments/Properties	The controled materials "crushed rock added with 2% GP cement						
Setup Parameters							
****************							
Dynamic loading options							
Wave shape	Square pulse						
Load duration (msec)	1000						
Cycle duration (msec)	3000						
Contact stress [% of max. stress]	1						
Conditioning Cycles	500						
Cycles per test sequence	500						
Shear test options							
Confining pressure (kPa)	34.5						
Strain rate (%/min)	1						
Gauge length (mm)	200						
Test termination strain (%)							

Sequence #	Confining Pressure (kPa)	Maximum Stress (kPa)
0	50	350
1	50	350
2	50	350
3	50	350
4	50	350
5	50	350
6	50	350
7	50	350
8	50	350
9	50	350
10	50	350
11	50	350
12	50	350
13	50	350
14	50	350
15	50	350
16	50	350
17	50	350
18	50	350
19	50	350
20	50	450
21	50	450
22	50	450
23	50	450
24	50	450
25	50	450
26	50	450
27	50	450
28	50	450
29	50	450
30	50	450
31	50	450
32	50	450

33	50	450
34	50	450
35	50	450
36	50	450
37	50	450
38	50	450
39	50	450
40	50	550
41	50	550
42	50	550
43	50	550
44	50	550
45	50	550
46	50	550
47	50	550
48	50	550
49	50	550
50	50	550
51	50	550
52	50	550
53	50	550
54	50	550
55	50	550
56	50	550
57	50	550
58	50	550
59	50	550

Calibration Information
****

Channel description	Filename	Transducer description	Span	Units	Date	Linearised
A: Axial Force	Y12346.CAR	STC5000 S/N: Y12346 +/-20kN	40	kN	7/12/2005	No
B: Actuator LVDT	941C-340.CAR	AC-15 S/N: M992941C-340 +/-15mm	30	mm	7/12/2005	No
C: Axial LVDT #1	83047.car	D6-05000A S/N: 83047 +/-5mm	10	mm	20/12/2005	Yes
D: Axial LVDT #2	83048.car	D6-05000A S/N: 83048 +/-5mm	10	mm	20/12/2005	Yes
E: Confining Pressure	S054042.CAR	Pressure S/N: S054042 +/-600kPa	1200	kPa	22/02/2006	No

Test Results
****

Start date and time	Tuesday	October 24	2006	at 12:52 PM

Sequence Number	0						
Cycle Number	496	497	498	499	500	Average	Std Dev.
Resilient Modulus (MPa)	303.975605	300.747145	304.533063	302.882167	300.77909	302.583414	1.764656
Resilient micro-strain	1137.423687	1149.6337	1131.257631	1137.423687	1149.5116	1141.050061	8.177245
Confining pressure (kPa)	50.10989	50.40293	50.40293	50.40293	50.10989	50.285714	0.160505
Maximum axial stress (kPa)	350.72386	350.72386	349.480158	349.480158	350.72386	350.226379	0.681203
Cyclic stress (kPa)	345.749053	345.749053	344.505352	344.505352	345.749053	345.251573	0.681203
Contact stress (kPa)	4.974807	4.974807	4.974807	4.974807	4.974807	4.974807	0
Permanent strain (%)	0.428651	0.428651	0.428651	0.428651	0.428651	0.428651	0
Maximum load (kN)	2.754579	2.754579	2.744811	2.744811	2.754579	2.750672	0.00535
Cyclic load (kN)	2.715507	2.715507	2.705739	2.705739	2.715507	2.7116	0.00535
Contact load (kN)	0.039072	0.039072	0.039072	0.039072	0.039072	0.039072	0
Average resilient def. (mm)	0.227485	0.229927	0.226252	0.227485	0.229902	0.22821	0.001635
Axial 1 resilient def. (mm)	0.216581	0.218999	0.216581	0.216581	0.221416	0.218032	0.002162
Axial 2 resilient def. (mm)	0.238388	0.240855	0.235922	0.238388	0.238388	0.238388	0.001744
Actuator resilient def. (mm)	0.351648	0.358974	0.344322	0.351648	0.358974	0.353114	0.006129
Average permanent def. (mm)	0.857302	0.857302	0.857302	0.857302	0.857302	0.857302	0
Axial 1 permanent def. (mm)	0.867448	0.867448	0.867448	0.867448	0.867448	0.867448	0
Axial 2 permanent def. (mm)	0.847155	0.847155	0.847155	0.847155	0.847155	0.847155	0
Actuator permanent def. (mm)	0.871795	0.871795	0.871795	0.871795	0.871795	0.871795	0

Sequence Number	1						
Cycle Number	496	497	498	499	500	Average	Std Dev.
Resilient Modulus (MPa)	299.190105	299.190105	302.385044	304.549499	301.281242	301.319199	2.271475
Resilient micro-strain	1155.616606	1155.616606	1143.406593	1131.196581	1143.467643	1145.860806	10.212017
Confining pressure (kPa)	50.40293	50.40293	50.10989	50.10989	50.40293	50.285714	0.160505
Maximum axial stress (kPa)	350.72386	350.72386	350.72386	349.480158	349.480158	350.226379	0.681203
Cyclic stress (kPa)	345.749053	345.749053	345.749053	344.505352	344.505352	345.251573	0.681203
Contact stress (kPa)	4.974807	4.974807	4.974807	4.974807	4.974807	4.974807	0
Permanent strain (%)	0.450018	0.450018	0.450018	0.450018	0.449408	0.449896	0.000273
Maximum load (kN)	2.754579	2.754579	2.754579	2.744811	2.744811	2.750672	0.00535
Cyclic load (kN)	2.715507	2.715507	2.715507	2.705739	2.705739	2.7116	0.00535
Contact load (kN)	0.039072	0.039072	0.039072	0.039072	0.039072	0.039072	0
Average resilient def. (mm)	0.231123	0.231123	0.228681	0.226239	0.228694	0.229172	0.002042
Axial 1 resilient def. (mm)	0.223419	0.223419	0.221001	0.218584	0.218584	0.221001	0.002418
Axial 2 resilient def. (mm)	0.238828	0.238828	0.236361	0.233895	0.238803	0.237343	0.002202
Actuator resilient def. (mm)	0.358974	0.351648	0.351648	0.344322	0.351648	0.351648	0.00518

Average permanent def. (mm)	0.900037	0.900037	0.900037	0.900037	0.898816	0.899792	0.000546
Axial 1 permanent def. (mm)	0.908962	0.908962	0.908962	0.908962	0.908962	0.908962	0
Axial 2 permanent def. (mm)	0.891111	0.891111	0.891111	0.891111	0.888669	0.890623	0.001092
Actuator permanent def. (mm)	0.923077	0.923077	0.923077	0.923077	0.915751	0.921612	0.003276
Sequence Number	2						
Cycle Number	496	497	498	499	500	Average	Std Dev.
Resilient Modulus (MPa)	304.533063	307.872642	302.914685	304.00824	300.77909	304.021544	2.589953
Resilient micro-strain	1131.257631	1118.986569	1137.301587	1137.301587	1149.5116	1134.871795	11.085286
Confining pressure (kPa)	50.40293	50.40293	50.40293	50.40293	50.40293	50.40293	0
Maximum axial stress (kPa)	349.480158	349.480158	349.480158	350.72386	350.72386	349.977639	0.681203
Cyclic stress (kPa)	344.505352	344.505352	344.505352	345.749053	345.749053	345.002832	0.681203
Contact stress (kPa)	4.974807	4.974807	4.974807	4.974807	4.974807	4.974807	0
Permanent strain (%)	0.462839	0.463449	0.462839	0.462839	0.462839	0.462961	0.000273
Maximum load (kN)	2.744811	2.744811	2.744811	2.754579	2.754579	2.748718	0.00535
Cyclic load (kN)	2.705739	2.705739	2.705739	2.715507	2.715507	2.709646	0.00535
Contact load (kN)	0.039072	0.039072	0.039072	0.039072	0.039072	0.039072	0
Average resilient def. (mm)	0.226252	0.223797	0.22746	0.22746	0.229902	0.226974	0.002217
Axial 1 resilient def. (mm)	0.215897	0.215897	0.218315	0.218315	0.220733	0.217832	0.002023
Axial 2 resilient def. (mm)	0.236606	0.231697	0.236606	0.236606	0.239072	0.236117	0.002692
Actuator resilient def. (mm)	0.351648	0.344322	0.344322	0.351648	0.358974	0.350183	0.006129
Average permanent def. (mm)	0.925678	0.926899	0.925678	0.925678	0.925678	0.925922	0.000546
Axial 1 permanent def. (mm)	0.935824	0.935824	0.935824	0.935824	0.935824	0.935824	0
Axial 2 permanent def. (mm)	0.915531	0.917973	0.915531	0.915531	0.915531	0.91602	0.001092
Actuator permanent def. (mm)	0.937729	0.945055	0.945055	0.937729	0.937729	0.940659	0.004013
Sequence Number	3						
Cycle Number	496	497	498	499	500	Average	Std Dev.
Resilient Modulus (MPa)	301.853537	304.565936	306.235289	302.40119	302.947209	303.600632	1.788239
Resilient micro-strain	1137.179487	1131.135531	1124.969475	1143.345543	1137.179487	1134.761905	6.971559
Confining pressure (kPa)	50.695971	50.40293	50.10989	50.40293	50.695971	50.461538	0.245175
Maximum axial stress (kPa)	349.480158	349.480158	349.480158	350.72386	349.480158	349.728899	0.5562
Cyclic stress (kPa)	343.26165	344.505352	344.505352	345.749053	344.505352	344.505352	0.87943
Contact stress (kPa)	6.218508	4.974807	4.974807	4.974807	4.974807	5.223547	0.5562
Permanent strain (%)	0.472619	0.472002	0.472619	0.472002	0.472002	0.472249	0.000338
Maximum load (kN)	2.744811	2.744811	2.744811	2.754579	2.744811	2.746764	0.004368
Cyclic load (kN)	2.695971	2.705739	2.705739	2.715507	2.705739	2.705739	0.006907
Contact load (kN)	0.04884	0.039072	0.039072	0.039072	0.039072	0.041026	0.004368
Average resilient def. (mm)	0.227436	0.226227	0.224994	0.228669	0.227436	0.226952	0.001394
Axial 1 resilient def. (mm)	0.220562	0.218144	0.218144	0.220562	0.220562	0.219595	0.001324
Axial 2 resilient def. (mm)	0.23431	0.23431	0.231844	0.236777	0.23431	0.23431	0.001744
Actuator resilient def. (mm)	0.351648	0.344322	0.344322	0.351648	0.351648	0.348718	0.004013
Average permanent def. (mm)	0.945238	0.944005	0.945238	0.944005	0.944005	0.944498	0.000675
Axial 1 permanent def. (mm)	0.952918	0.952918	0.952918	0.952918	0.952918	0.952918	0
Axial 2 permanent def. (mm)	0.937558	0.935092	0.937558	0.935092	0.935092	0.936078	0.001351
Actuator permanent def. (mm)	0.959707	0.959707	0.959707	0.959707	0.959707	0.959707	0
Sequence Number	4						
Cycle Number	496	497	498	499	500	Average	Std Dev.
Resilient Modulus (MPa)	300.95491	302.578912	301.458286	306.930626	299.872338	302.359014	2.734701
Resilient micro-strain	1148.840049	1142.673993	1142.796093	1130.525031	1148.840049	1142.735043	7.4772
Confining pressure (kPa)	51.282051	50.40293	50.40293	50.695971	50.40293	50.637363	0.382078
Maximum axial stress (kPa)	350.72386	350.72386	349.480158	350.72386	349.480158	350.226379	0.681203
Cyclic stress (kPa)	345.749053	345.749053	344.505352	346.992755	344.505352	345.500313	1.040555
Contact stress (kPa)	4.974807	4.974807	4.974807	3.731105	4.974807	4.726066	0.5562
Permanent strain (%)	0.479365	0.479982	0.478755	0.479982	0.479365	0.47949	0.000514
Maximum load (kN)	2.754579	2.754579	2.744811	2.754579	2.744811	2.750672	0.00535
Cyclic load (kN)	2.715507	2.715507	2.705739	2.725275	2.705739	2.713553	0.008173
Contact load (kN)	0.039072	0.039072	0.039072	0.029304	0.039072	0.037118	0.004368
Average resilient def. (mm)	0.229768	0.228535	0.228559	0.226105	0.229768	0.228547	0.001495
Axial 1 resilient def. (mm)	0.222833	0.222833	0.222857	0.220415	0.222833	0.222354	0.001084
Axial 2 resilient def. (mm)	0.236703	0.234237	0.234261	0.231795	0.236703	0.23474	0.002053
Actuator resilient def. (mm)	0.358974	0.351648	0.351648	0.344322	0.358974	0.353114	0.006129
Average permanent def. (mm)	0.95873	0.959963	0.957509	0.959963	0.95873	0.958979	0.001027
Axial 1 permanent def. (mm)	0.96757	0.96757	0.965128	0.96757	0.96757	0.967082	0.001092
Axial 2 permanent def. (mm)	0.94989	0.952357	0.94989	0.952357	0.94989	0.950877	0.001351
Actuator permanent def. (mm)	0.974359	0.981685	0.974359	0.981685	0.974359	0.977289	0.004013
Sequence Number	5						
Cycle Number	496	497	498	499	500	Average	Std Dev.
Resilient Modulus (MPa)	301.635539	304.351327	303.256538	301.651663	297.36756	301.652526	2.656012
Resilient micro-strain	1142.124542	1136.019536	1136.019536	1142.063492	1154.334554	1142.112332	7.477125
Confining pressure (kPa)	50.10989	50.40293	50.40293	50.40293	50.40293	50.344322	0.131052
Maximum axial stress (kPa)	349.480158	350.72386	349.480158	350.72386	349.480158	349.977639	0.681203
Cyclic stress (kPa)	344.505352	345.749053	344.505352	344.505352	343.26165	344.505352	0.87943
Contact stress (kPa)	4.974807	4.974807	4.974807	6.218508	6.218508	5.472287	0.681203
Permanent strain (%)	0.485507	0.485507	0.485507	0.485507	0.48489	0.485383	0.000276
Maximum load (kN)	2.744811	2.754579	2.744811	2.754579	2.744811	2.748718	0.00535

Cyclic load (kN)	2.705739	2.715507	2.705739	2.705739	2.695971	2.705739	0.006907
Contact load (kN)	0.039072	0.039072	0.039072	0.04884	0.04884	0.042979	0.00535
Average resilient def. (mm)	0.228425	0.227204	0.227204	0.228413	0.230867	0.228422	0.001495
Axial 1 resilient def. (mm)	0.222735	0.222735	0.222735	0.225153	0.225153	0.223702	0.001324
Axial 2 resilient def. (mm)	0.234115	0.231673	0.231673	0.231673	0.236581	0.233143	0.002194
Actuator resilient def. (mm)	0.351648	0.351648	0.351648	0.336996	0.351648	0.348718	0.006553
Average permanent def. (mm)	0.971013	0.971013	0.971013	0.971013	0.96978	0.970767	0.000552
Axial 1 permanent def. (mm)	0.977338	0.977338	0.977338	0.977338	0.977338	0.977338	0
Axial 2 permanent def. (mm)	0.964689	0.964689	0.964689	0.964689	0.962222	0.964195	0.001103
Actuator permanent def. (mm)	0.996337	0.996337	0.996337	1.003663	0.996337	0.997802	0.003276
Sequence Number	6						
Cycle Number	496	497	498	499	500	Average	Std Dev.
Resilient Modulus (MPa)	303.386971	305.026901	307.808549	303.419597	303.925721	304.713548	1.852836
Resilient micro-strain	1135.531136	1129.426129	1123.260073	1135.409035	1129.426129	1130.610501	5.100805
Confining pressure (kPa)	50.695971	50.40293	50.40293	50.10989	50.40293	50.40293	0.207211
Maximum axial stress (kPa)	349.480158	349.480158	350.72386	349.480158	349.480158	349.728899	0.5562
Cyclic stress (kPa)	344.505352	344.505352	345.749053	344.505352	343.26165	344.505352	0.87943
Contact stress (kPa)	4.974807	4.974807	4.974807	4.974807	6.218508	5.223547	0.5562
Permanent strain (%)	0.491026	0.491026	0.491642	0.491642	0.491026	0.491272	0.000338
Maximum load (kN)	2.744811	2.744811	2.754579	2.744811	2.744811	2.746764	0.004368
Cyclic load (kN)	2.705739	2.705739	2.715507	2.705739	2.695971	2.705739	0.006907
Contact load (kN)	0.039072	0.039072	0.039072	0.039072	0.04884	0.041026	0.004368
Average resilient def. (mm)	0.227106	0.225885	0.224652	0.227082	0.225885	0.226122	0.00102
Axial 1 resilient def. (mm)	0.220195	0.220195	0.220195	0.222613	0.220195	0.220679	0.001081
Axial 2 resilient def. (mm)	0.234017	0.231575	0.229109	0.231551	0.231575	0.231565	0.001735
Actuator resilient def. (mm)	0.351648	0.351648	0.344322	0.344322	0.344322	0.347253	0.004013
Average permanent def. (mm)	0.982051	0.982051	0.983284	0.983284	0.982051	0.982545	0.000675
Axial 1 permanent def. (mm)	0.989548	0.989548	0.989548	0.989548	0.989548	0.989548	0
Axial 2 permanent def. (mm)	0.974554	0.974554	0.977021	0.977021	0.974554	0.975541	0.001351
Actuator permanent def. (mm)	0.996337	0.996337	1.003663	1.003663	0.996337	0.999267	0.004013
Sequence Number	7						
Cycle Number	496	497	498	499	500	Average	Std Dev.
Resilient Modulus (MPa)	301.909885	303.517516	304.613247	301.387339	301.877583	302.661114	1.355085
Resilient micro-strain	1141.086691	1135.042735	1135.042735	1147.191697	1141.208791	1139.91453	5.086133
Confining pressure (kPa)	49.52381	50.40293	50.40293	50.40293	50.695971	50.285714	0.444418
Maximum axial stress (kPa)	349.480158	349.480158	350.72386	350.72386	349.480158	349.977639	0.681203
Cyclic stress (kPa)	344.505352	344.505352	345.749053	345.749053	344.505352	345.002832	0.681203
Contact stress (kPa)	4.974807	4.974807	4.974807	4.974807	4.974807	4.974807	0
Permanent strain (%)	0.495934	0.495324	0.495324	0.495324	0.494707	0.495322	0.000434
Maximum load (kN)	2.744811	2.744811	2.754579	2.754579	2.744811	2.748718	0.00535
Cyclic load (kN)	2.705739	2.705739	2.715507	2.715507	2.705739	2.709646	0.00535
Contact load (kN)	0.039072	0.039072	0.039072	0.039072	0.039072	0.039072	0
Average resilient def. (mm)	0.228217	0.227009	0.227009	0.229438	0.228242	0.227983	0.001017
Axial 1 resilient def. (mm)	0.222515	0.22254	0.22254	0.224957	0.22254	0.223018	0.001084
Axial 2 resilient def. (mm)	0.233919	0.231477	0.231477	0.233919	0.233944	0.232947	0.001342
Actuator resilient def. (mm)	0.351648	0.351648	0.344322	0.351648	0.344322	0.348718	0.004013
Average permanent def. (mm)	0.991868	0.990647	0.990647	0.990647	0.989414	0.990645	0.000868
Axial 1 permanent def. (mm)	0.999316	0.996874	0.996874	0.996874	0.996874	0.997363	0.001092
Axial 2 permanent def. (mm)	0.98442	0.98442	0.98442	0.98442	0.981954	0.983927	0.001103
Actuator permanent def. (mm)	1.010989	1.003663	1.010989	1.003663	1.003663	1.006593	0.004013
Sequence Number	8						
Cycle Number	496	497	498	499	500	Average	Std Dev.
Resilient Modulus (MPa)	303.615499	301.483604	301.483604	304.744377	301.483604	302.562137	1.529824
Resilient micro-strain	1134.676435	1146.825397	1146.825397	1134.554335	1146.825397	1141.941392	6.687838
Confining pressure (kPa)	50.989011	50.10989	50.40293	50.40293	50.695971	50.520147	0.334117
Maximum axial stress (kPa)	349.480158	350.72386	350.72386	350.72386	350.72386	350.47512	0.5562
Cyclic stress (kPa)	344.505352	345.749053	345.749053	345.749053	345.749053	345.500313	0.5562
Contact stress (kPa)	4.974807	4.974807	4.974807	4.974807	4.974807	4.974807	0
Permanent strain (%)	0.499005	0.499005	0.499005	0.500232	0.499005	0.49925	0.000549
Maximum load (kN)	2.744811	2.754579	2.754579	2.754579	2.754579	2.752625	0.004368
Cyclic load (kN)	2.705739	2.715507	2.715507	2.715507	2.715507	2.713553	0.004368
Contact load (kN)	0.039072	0.039072	0.039072	0.039072	0.039072	0.039072	0
Average resilient def. (mm)	0.226935	0.229365	0.229365	0.226911	0.229365	0.228388	0.001338
Axial 1 resilient def. (mm)	0.222466	0.224884	0.224884	0.222442	0.224884	0.223912	0.001331
Axial 2 resilient def. (mm)	0.231404	0.233846	0.233846	0.23138	0.233846	0.232864	0.001344
Actuator resilient def. (mm)	0.344322	0.351648	0.358974	0.351648	0.358974	0.353114	0.006129
Average permanent def. (mm)	0.99801	0.99801	0.99801	1.000464	0.99801	0.998501	0.001098
Axial 1 permanent def. (mm)	1.0042	1.0042	1.0042	1.006642	1.0042	1.004689	0.001092
Axial 2 permanent def. (mm)	0.991819	0.991819	0.991819	0.994286	0.991819	0.992313	0.001103
Actuator permanent def. (mm)	1.018315	1.018315	1.018315	1.018315	1.018315	1.018315	0
Sequence Number	9						
Cycle Number	496	497	498	499	500	Average	Std Dev.
Resilient Modulus (MPa)	302.071498	305.357016	302.60082	300.479109	303.178238	302.737336	1.77614
Resilient micro-strain	1140.47619	1128.205128	1134.371184	1146.520147	1140.41514	1137.997558	6.958181

Confining pressure (kPa)	50.40293	50.40293	50.40293	50.40293	50.40293	50.40293	0
Maximum axial stress (kPa)	349.480158	349.480158	349.480158	349.480158	350.72386	349.728899	0.5562
Cyclic stress (kPa)	344.505352	344.505352	343.26165	344.505352	345.749053	344.505352	0.87943
Contact stress (kPa)	4.974807	4.974807	6.218508	4.974807	4.974807	5.223547	0.5562
Permanent strain (%)	0.503284	0.503901	0.503284	0.503284	0.50268	0.503287	0.000432
Maximum load (kN)	2.744811	2.744811	2.744811	2.744811	2.754579	2.746764	0.004368
Cyclic load (kN)	2.705739	2.705739	2.695971	2.705739	2.715507	2.705739	0.006907
Contact load (kN)	0.039072	0.039072	0.04884	0.039072	0.039072	0.041026	0.004368
Average resilient def. (mm)	0.228095	0.225641	0.226874	0.229304	0.228083	0.2276	0.001392
Axial 1 resilient def. (mm)	0.222418	0.222418	0.222418	0.224835	0.224835	0.223385	0.001324
Axial 2 resilient def. (mm)	0.233773	0.228864	0.231331	0.233773	0.231331	0.231814	0.002052
Actuator resilient def. (mm)	0.351648	0.336996	0.344322	0.351648	0.351648	0.347253	0.006553
Average permanent def. (mm)	1.006569	1.007802	1.006569	1.006569	1.00536	1.006574	0.000863
Axial 1 permanent def. (mm)	1.013919	1.013919	1.013919	1.013919	1.011502	1.013436	0.001081
Axial 2 permanent def. (mm)	0.999219	1.001685	0.999219	0.999219	0.999219	0.999712	0.001103
Actuator permanent def. (mm)	1.025641	1.032967	1.025641	1.025641	1.025641	1.027106	0.003276
Sequence Number	10						
Cycle Number	496	497	498	499	500	Average	Std Dev.
Resilient Modulus (MPa)	303.746241	302.120016	303.746241	304.875619	300.527116	303.003047	1.697143
Resilient micro-strain	1134.188034	1140.29304	1134.188034	1134.065934	1146.336996	1137.814408	5.457343
Confining pressure (kPa)	51.282051	50.40293	50.40293	50.40293	50.695971	50.637363	0.382078
Maximum axial stress (kPa)	349.480158	349.480158	349.480158	350.72386	350.72386	349.977639	0.681203
Cyclic stress (kPa)	344.505352	344.505352	344.505352	345.749053	344.505352	344.754092	0.5562
Contact stress (kPa)	4.974807	4.974807	4.974807	4.974807	6.218508	5.223547	0.5562
Permanent strain (%)	0.506947	0.506947	0.506947	0.507564	0.506947	0.507071	0.000276
Maximum load (kN)	2.744811	2.744811	2.744811	2.754579	2.754579	2.748718	0.00535
Cyclic load (kN)	2.705739	2.705739	2.705739	2.715507	2.705739	2.707692	0.004368
Contact load (kN)	0.039072	0.039072	0.039072	0.039072	0.04884	0.041026	0.004368
Average resilient def. (mm)	0.226838	0.228059	0.226838	0.226813	0.229267	0.227563	0.001091
Axial 1 resilient def. (mm)	0.222418	0.222418	0.222418	0.224835	0.224835	0.223385	0.001324
Axial 2 resilient def. (mm)	0.231258	0.2337	0.231258	0.228791	0.2337	0.231741	0.002052
Actuator resilient def. (mm)	0.344322	0.344322	0.344322	0.344322	0.351648	0.345788	0.003276
Average permanent def. (mm)	1.013895	1.013895	1.013895	1.015128	1.013895	1.014142	0.000552
Axial 1 permanent def. (mm)	1.021172	1.021172	1.021172	1.021172	1.021172	1.021172	0
Axial 2 permanent def. (mm)	1.006618	1.006618	1.006618	1.009084	1.006618	1.007111	0.001103
Actuator permanent def. (mm)	1.040293	1.040293	1.040293	1.040293	1.040293	1.040293	0
Sequence Number	11						
Cycle Number	496	497	498	499	500	Average	Std Dev.
Resilient Modulus (MPa)	306.00524	303.308135	304.353461	303.811654	306.55892	304.807482	1.409611
Resilient micro-strain	1133.943834	1139.92674	1127.838828	1133.943834	1127.838828	1132.698413	5.064138
Confining pressure (kPa)	50.40293	50.40293	50.40293	49.81685	50.40293	50.285714	0.262103
Maximum axial stress (kPa)	351.967562	351.967562	349.480158	349.480158	350.72386	350.72386	1.243702
Cyclic stress (kPa)	346.992755	345.749053	343.26165	344.505352	345.749053	345.251573	1.418038
Contact stress (kPa)	4.974807	6.218508	6.218508	4.974807	4.974807	5.472287	0.681203
Permanent strain (%)	0.511832	0.512448	0.511227	0.511227	0.511227	0.511592	0.000545
Maximum load (kN)	2.764347	2.764347	2.744811	2.744811	2.754579	2.754579	0.009768
Cyclic load (kN)	2.725275	2.715507	2.695971	2.705739	2.715507	2.7116	0.011137
Contact load (kN)	0.039072	0.04884	0.04884	0.039072	0.039072	0.042979	0.00535
Average resilient def. (mm)	0.226789	0.227985	0.225568	0.226789	0.225568	0.22654	0.001013
Axial 1 resilient def. (mm)	0.222418	0.224835	0.222418	0.222418	0.222418	0.222901	0.001081
Axial 2 resilient def. (mm)	0.23116	0.231136	0.228718	0.23116	0.228718	0.230178	0.001333
Actuator resilient def. (mm)	0.351648	0.351648	0.344322	0.344322	0.344322	0.347253	0.004013
Average permanent def. (mm)	1.023663	1.024896	1.022454	1.022454	1.022454	1.023184	0.001091
Axial 1 permanent def. (mm)	1.030842	1.030842	1.028425	1.028425	1.028425	1.029392	0.001324
Axial 2 permanent def. (mm)	1.016484	1.01895	1.016484	1.016484	1.016484	1.016977	0.001103
Actuator permanent def. (mm)	1.040293	1.040293	1.040293	1.040293	1.040293	1.040293	0
Sequence Number	12						
Cycle Number	496	497	498	499	500	Average	Std Dev.
Resilient Modulus (MPa)	304.415475	303.844371	307.135343	302.74746	298.046215	303.237773	3.321847
Resilient micro-strain	1139.86569	1133.821734	1121.672772	1133.821734	1164.224664	1138.681319	15.735208
Confining pressure (kPa)	50.695971	50.40293	50.40293	50.10989	50.40293	50.40293	0.207211
Maximum axial stress (kPa)	351.967562	350.72386	349.480158	349.480158	351.967562	350.72386	1.243702
Cyclic stress (kPa)	346.992755	344.505352	344.505352	343.26165	346.992755	345.251573	1.668601
Contact stress (kPa)	4.974807	6.218508	4.974807	6.218508	4.974807	5.472287	0.681203
Permanent strain (%)	0.513669	0.513669	0.513669	0.513669	0.512448	0.513425	0.000546
Maximum load (kN)	2.764347	2.754579	2.744811	2.744811	2.764347	2.754579	0.009768
Cyclic load (kN)	2.725275	2.705739	2.705739	2.695971	2.725275	2.7116	0.013105
Contact load (kN)	0.039072	0.04884	0.039072	0.04884	0.039072	0.042979	0.00535
Average resilient def. (mm)	0.227973	0.226764	0.224335	0.226764	0.232845	0.227736	0.003147
Axial 1 resilient def. (mm)	0.224835	0.222418	0.22	0.222418	0.22967	0.223868	0.003666
Axial 2 resilient def. (mm)	0.231111	0.231111	0.228669	0.231111	0.23602	0.231604	0.002685
Actuator resilient def. (mm)	0.351648	0.351648	0.344322	0.351648	0.3663	0.353114	0.008025
Average permanent def. (mm)	1.027338	1.027338	1.027338	1.027338	1.024896	1.02685	0.001092
Axial 1 permanent def. (mm)	1.03326	1.03326	1.03326	1.03326	1.030842	1.032777	0.001081
Axial 2 permanent def. (mm)	1.021416	1.021416	1.021416	1.021416	1.01895	1.020923	0.001103

Actuator permanent def. (mm)	1.047619	1.040293	1.047619	1.040293	1.040293	1.043223	0.004013
Sequence Number	13						
Cycle Number	496	497	498	499	500	Average	Std Dev.
Resilient Modulus (MPa)	303.32438	300.141475	307.185501	303.860732	302.217098	303.345837	2.576363
Resilient micro-strain	1139.86569	1151.953602	1121.489621	1133.760684	1139.92674	1137.399267	11.07538
Confining pressure (kPa)	50.40293	50.40293	50.40293	50.40293	50.40293	50.40293	0
Maximum axial stress (kPa)	350.72386	350.72386	349.480158	349.480158	349.480158	349.977639	0.681203
Cyclic stress (kPa)	345.749053	345.749053	344.505352	344.505352	344.505352	345.002832	0.681203
Contact stress (kPa)	4.974807	4.974807	4.974807	4.974807	4.974807	4.974807	0
Permanent strain (%)	0.51489	0.51489	0.515507	0.51489	0.514274	0.51489	0.000436
Maximum load (kN)	2.754579	2.754579	2.744811	2.744811	2.744811	2.748718	0.00535
Cyclic load (kN)	2.715507	2.715507	2.705739	2.705739	2.705739	2.709646	0.00535
Contact load (kN)	0.039072	0.039072	0.039072	0.039072	0.039072	0.039072	0
Average resilient def. (mm)	0.227973	0.230391	0.224298	0.226752	0.227985	0.22748	0.002215
Axial 1 resilient def. (mm)	0.222418	0.227253	0.222418	0.222418	0.222418	0.223385	0.002162
Axial 2 resilient def. (mm)	0.233529	0.233529	0.226178	0.231087	0.233553	0.231575	0.003198
Actuator resilient def. (mm)	0.351648	0.358974	0.336996	0.351648	0.344322	0.348718	0.008353
Average permanent def. (mm)	1.02978	1.02978	1.031013	1.02978	1.028547	1.02978	0.000872
Axial 1 permanent def. (mm)	1.035678	1.035678	1.035678	1.035678	1.035678	1.035678	0
Axial 2 permanent def. (mm)	1.023883	1.023883	1.026349	1.023883	1.021416	1.023883	0.001744
Actuator permanent def. (mm)	1.047619	1.047619	1.054945	1.047619	1.047619	1.049084	0.003276
Sequence Number	14						
Cycle Number	496	497	498	499	500	Average	Std Dev.
Resilient Modulus (MPa)	303.877095	300.655211	305.006974	304.974125	303.877095	303.6781	1.77923
Resilient micro-strain	1133.699634	1145.848596	1133.577534	1133.699634	1133.699634	1136.105006	5.447089
Confining pressure (kPa)	50.10989	50.40293	50.10989	50.40293	50.40293	50.285714	0.160505
Maximum axial stress (kPa)	349.480158	349.480158	350.72386	350.72386	349.480158	349.977639	0.681203
Cyclic stress (kPa)	344.505352	344.505352	345.749053	345.749053	344.505352	345.002832	0.681203
Contact stress (kPa)	4.974807	4.974807	4.974807	4.974807	4.974807	4.974807	0
Permanent strain (%)	0.516111	0.516111	0.516728	0.516111	0.516111	0.516234	0.000276
Maximum load (kN)	2.744811	2.744811	2.754579	2.754579	2.744811	2.748718	0.00535
Cyclic load (kN)	2.705739	2.705739	2.715507	2.715507	2.705739	2.709646	0.00535
Contact load (kN)	0.039072	0.039072	0.039072	0.039072	0.039072	0.039072	0
Average resilient def. (mm)	0.22674	0.22917	0.226716	0.22674	0.22674	0.227221	0.001089
Axial 1 resilient def. (mm)	0.222418	0.224835	0.224835	0.222418	0.222418	0.223385	0.001324
Axial 2 resilient def. (mm)	0.231062	0.233504	0.228596	0.231062	0.231062	0.231057	0.001735
Actuator resilient def. (mm)	0.351648	0.351648	0.344322	0.344322	0.344322	0.347253	0.004013
Average permanent def. (mm)	1.032222	1.032222	1.033455	1.032222	1.032222	1.032469	0.000552
Axial 1 permanent def. (mm)	1.038095	1.038095	1.038095	1.038095	1.038095	1.038095	0
Axial 2 permanent def. (mm)	1.026349	1.026349	1.028816	1.026349	1.026349	1.026842	0.001103
Actuator permanent def. (mm)	1.054945	1.054945	1.054945	1.054945	1.054945	1.054945	0
Sequence Number	15						
Cycle Number	496	497	498	499	500	Average	Std Dev.
Resilient Modulus (MPa)	308.883774	307.202225	306.104121	307.202225	305.555429	306.989555	1.276639
Resilient micro-strain	1115.323565	1121.428571	1133.577534	1121.428571	1127.472527	1123.846154	6.931347
Confining pressure (kPa)	50.10989	50.695971	50.40293	50.40293	50.40293	50.40293	0.207211
Maximum axial stress (kPa)	349.480158	349.480158	351.967562	349.480158	349.480158	349.977639	1.112401
Cyclic stress (kPa)	344.505352	344.505352	346.992755	344.505352	344.505352	345.002832	1.112401
Contact stress (kPa)	4.974807	4.974807	4.974807	4.974807	4.974807	4.974807	0
Permanent strain (%)	0.518553	0.518553	0.518553	0.518553	0.517949	0.518432	0.00027
Maximum load (kN)	2.744811	2.744811	2.764347	2.744811	2.744811	2.748718	0.008737
Cyclic load (kN)	2.705739	2.705739	2.725275	2.705739	2.705739	2.709646	0.008737
Contact load (kN)	0.039072	0.039072	0.039072	0.039072	0.039072	0.039072	0
Average resilient def. (mm)	0.223065	0.224286	0.226716	0.224286	0.225495	0.224769	0.001386
Axial 1 resilient def. (mm)	0.22	0.22	0.222418	0.22	0.222418	0.220967	0.001324
Axial 2 resilient def. (mm)	0.226129	0.228571	0.231013	0.228571	0.228571	0.228571	0.001727
Actuator resilient def. (mm)	0.351648	0.336996	0.351648	0.351648	0.344322	0.347253	0.006553
Average permanent def. (mm)	1.037106	1.037106	1.037106	1.037106	1.035897	1.036864	0.000541
Axial 1 permanent def. (mm)	1.04293	1.04293	1.04293	1.04293	1.040513	1.042447	0.001081
Axial 2 permanent def. (mm)	1.031282	1.031282	1.031282	1.031282	1.031282	1.031282	0
Actuator permanent def. (mm)	1.047619	1.054945	1.047619	1.047619	1.047619	1.049084	0.003276
Sequence Number	16						
Cycle Number	496	497	498	499	500	Average	Std Dev.
Resilient Modulus (MPa)	304.468827	303.40563	307.218949	307.218949	303.926195	305.24771	1.838334
Resilient micro-strain	1127.411477	1139.56044	1121.367521	1121.367521	1133.516484	1128.644689	7.910802
Confining pressure (kPa)	50.40293	50.40293	50.10989	50.40293	50.40293	50.344322	0.131052
Maximum axial stress (kPa)	349.480158	350.72386	349.480158	349.480158	349.480158	349.728899	0.5562
Cyclic stress (kPa)	343.26165	345.749053	344.505352	344.505352	344.505352	344.505352	0.87943
Contact stress (kPa)	6.218508	4.974807	4.974807	4.974807	4.974807	5.223547	0.5562
Permanent strain (%)	0.519774	0.519774	0.519774	0.519774	0.519774	0.519774	0
Maximum load (kN)	2.744811	2.754579	2.744811	2.744811	2.744811	2.746764	0.004368
Cyclic load (kN)	2.695971	2.715507	2.705739	2.705739	2.705739	2.705739	0.006907
Contact load (kN)	0.04884	0.039072	0.039072	0.039072	0.039072	0.041026	0.004368
Average resilient def. (mm)	0.225482	0.227912	0.224274	0.224274	0.226703	0.225729	0.001582

Axial 1 resilient def. (mm)	0.222418	0.224835	0.22	0.22	0.222418	0.221934	0.002023
Axial 2 resilient def. (mm)	0.228547	0.230989	0.228547	0.228547	0.230989	0.229524	0.001338
Actuator resilient def. (mm)	0.344322	0.351648	0.344322	0.344322	0.351648	0.347253	0.004013
Average permanent def. (mm)	1.039548	1.039548	1.039548	1.039548	1.039548	1.039548	0
Axial 1 permanent def. (mm)	1.045348	1.045348	1.045348	1.045348	1.045348	1.045348	0
Axial 2 permanent def. (mm)	1.033748	1.033748	1.033748	1.033748	1.033748	1.033748	0
Actuator permanent def. (mm)	1.054945	1.054945	1.054945	1.054945	1.054945	1.054945	0
Sequence Number	17						
Cycle Number	496	497	498	499	500	Average	Std Dev.
Resilient Modulus (MPa)	301.804929	303.421886	308.361619	302.845299	303.942565	304.07526	2.524113
Resilient micro-strain	1145.604396	1139.499389	1121.245421	1133.455433	1133.455433	1134.652015	9.028456
Confining pressure (kPa)	50.40293	50.40293	50.40293	50.40293	50.10989	50.344322	0.131052
Maximum axial stress (kPa)	350.72386	350.72386	350.72386	349.480158	349.480158	350.226379	0.681203
Cyclic stress (kPa)	345.749053	345.749053	345.749053	343.26165	344.505352	345.002832	1.112401
Contact stress (kPa)	4.974807	4.974807	4.974807	6.218508	4.974807	5.223547	0.5562
Permanent strain (%)	0.520995	0.520995	0.522216	0.520995	0.520995	0.521239	0.000546
Maximum load (kN)	2.754579	2.754579	2.754579	2.744811	2.744811	2.750672	0.00535
Cyclic load (kN)	2.715507	2.715507	2.715507	2.695971	2.705739	2.709646	0.008737
Contact load (kN)	0.039072	0.039072	0.039072	0.04884	0.039072	0.041026	0.004368
Average resilient def. (mm)	0.229121	0.2279	0.224249	0.226691	0.226691	0.22693	0.001806
Axial 1 resilient def. (mm)	0.224835	0.224835	0.22	0.222418	0.222418	0.222901	0.002023
Axial 2 resilient def. (mm)	0.233407	0.230965	0.228498	0.230965	0.230965	0.23096	0.001735
Actuator resilient def. (mm)	0.358974	0.344322	0.344322	0.351648	0.344322	0.348718	0.006553
Average permanent def. (mm)	1.04199	1.04199	1.044432	1.04199	1.04199	1.042479	0.001092
Axial 1 permanent def. (mm)	1.047766	1.047766	1.050183	1.047766	1.047766	1.048249	0.001081
Axial 2 permanent def. (mm)	1.036215	1.036215	1.038681	1.036215	1.036215	1.036708	0.001103
Actuator permanent def. (mm)	1.062271	1.069597	1.069597	1.062271	1.062271	1.065201	0.004013
Sequence Number	18						
Cycle Number	496	497	498	499	500	Average	Std Dev.
Resilient Modulus (MPa)	310.635124	306.69173	307.252405	303.421886	310.635124	307.727254	3.030899
Resilient micro-strain	1109.035409	1127.350427	1121.245421	1139.499389	1109.035409	1121.233211	12.9291
Confining pressure (kPa)	50.40293	50.40293	50.10989	50.40293	50.695971	50.40293	0.207211
Maximum axial stress (kPa)	349.480158	350.72386	349.480158	350.72386	349.480158	349.977639	0.681203
Cyclic stress (kPa)	344.505352	345.749053	344.505352	345.749053	344.505352	345.002832	0.681203
Contact stress (kPa)	4.974807	4.974807	4.974807	4.974807	4.974807	4.974807	0
Permanent strain (%)	0.523437	0.522821	0.522821	0.522821	0.523437	0.523067	0.000338
Maximum load (kN)	2.744811	2.754579	2.744811	2.754579	2.744811	2.748718	0.00535
Cyclic load (kN)	2.705739	2.715507	2.705739	2.715507	2.705739	2.709646	0.00535
Contact load (kN)	0.039072	0.039072	0.039072	0.039072	0.039072	0.039072	0
Average resilient def. (mm)	0.221807	0.22547	0.224249	0.2279	0.221807	0.224247	0.002586
Axial 1 resilient def. (mm)	0.217582	0.22	0.22	0.222418	0.217582	0.219516	0.002023
Axial 2 resilient def. (mm)	0.226032	0.23094	0.228498	0.233382	0.226032	0.228977	0.003195
Actuator resilient def. (mm)	0.336996	0.351648	0.336996	0.351648	0.344322	0.344322	0.007326
Average permanent def. (mm)	1.046874	1.045641	1.045641	1.045641	1.046874	1.046134	0.000675
Axial 1 permanent def. (mm)	1.052601	1.052601	1.052601	1.052601	1.052601	1.052601	0
Axial 2 permanent def. (mm)	1.041148	1.038681	1.038681	1.038681	1.041148	1.039668	0.001351
Actuator permanent def. (mm)	1.062271	1.054945	1.062271	1.054945	1.054945	1.057875	0.004013
Sequence Number	19						
Cycle Number	496	497	498	499	500	Average	Std Dev.
Resilient Modulus (MPa)	305.089129	306.741564	308.395202	305.638177	305.638177	306.30045	1.315967
Resilient micro-strain	1133.272283	1127.167277	1121.123321	1127.167277	1127.167277	1127.179487	4.295339
Confining pressure (kPa)	50.40293	49.81685	50.40293	50.40293	50.10989	50.227106	0.262103
Maximum axial stress (kPa)	350.72386	350.72386	350.72386	350.72386	349.480158	350.47512	0.5562
Cyclic stress (kPa)	345.749053	345.749053	345.749053	344.505352	344.505352	345.251573	0.681203
Contact stress (kPa)	4.974807	4.974807	4.974807	6.218508	4.974807	5.223547	0.5562
Permanent strain (%)	0.524658	0.524658	0.524658	0.524658	0.524658	0.524658	0
Maximum load (kN)	2.754579	2.754579	2.754579	2.754579	2.744811	2.752625	0.004368
Cyclic load (kN)	2.715507	2.715507	2.715507	2.705739	2.705739	2.7116	0.00535
Contact load (kN)	0.039072	0.039072	0.039072	0.04884	0.039072	0.041026	0.004368
Average resilient def. (mm)	0.226654	0.225433	0.224225	0.225433	0.225433	0.225436	0.000859
Axial 1 resilient def. (mm)	0.222418	0.222418	0.22	0.222418	0.222418	0.221934	0.001081
Axial 2 resilient def. (mm)	0.230891	0.228449	0.228449	0.228449	0.228449	0.228938	0.001092
Actuator resilient def. (mm)	0.351648	0.358974	0.344322	0.351648	0.344322	0.350183	0.006129
Average permanent def. (mm)	1.049316	1.049316	1.049316	1.049316	1.049316	1.049316	0
Axial 1 permanent def. (mm)	1.055018	1.055018	1.055018	1.055018	1.055018	1.055018	0
Axial 2 permanent def. (mm)	1.043614	1.043614	1.043614	1.043614	1.043614	1.043614	0
Actuator permanent def. (mm)	1.062271	1.062271	1.062271	1.062271	1.062271	1.062271	0
Sequence Number	20						
Cycle Number	496	497	498	499	500	Average	Std Dev.
Resilient Modulus (MPa)	340.883257	345.744915	344.776441	344.776441	344.776441	344.191499	1.896315
Resilient micro-strain	1302.503053	1284.188034	1284.188034	1284.188034	1284.188034	1287.851038	8.190725
Confining pressure (kPa)	50.695971	50.40293	50.10989	50.40293	50.40293	50.40293	0.207211
Maximum axial stress (kPa)	450.21999	450.21999	448.976289	448.976289	448.976289	449.473769	0.681203
Cyclic stress (kPa)	444.001482	444.001482	442.757781	442.757781	442.757781	443.255261	0.681203

Contact stress (kPa)	6.218508	6.218508	6.218508	6.218508	6.218508	6.218508	0
Permanent strain (%)	0.542973	0.544194	0.544194	0.544194	0.544194	0.54395	0.000546
Maximum load (kN)	3.53602	3.53602	3.526252	3.526252	3.526252	3.530159	0.00535
Cyclic load (kN)	3.487179	3.487179	3.477411	3.477411	3.477411	3.481319	0.00535
Contact load (kN)	0.04884	0.04884	0.04884	0.04884	0.04884	0.04884	0
Average resilient def. (mm)	0.260501	0.256838	0.256838	0.256838	0.256838	0.25757	0.001638
Axial 1 resilient def. (mm)	0.253846	0.251429	0.251429	0.251429	0.251429	0.251912	0.001081
Axial 2 resilient def. (mm)	0.267155	0.262247	0.262247	0.262247	0.262247	0.263228	0.002195
Actuator resilient def. (mm)	0.417582	0.40293	0.40293	0.410256	0.40293	0.407326	0.006553
Average permanent def. (mm)	1.085946	1.088388	1.088388	1.088388	1.088388	1.0879	0.001092
Axial 1 permanent def. (mm)	1.091282	1.0937	1.0937	1.0937	1.0937	1.093216	0.001081
Axial 2 permanent def. (mm)	1.080611	1.083077	1.083077	1.083077	1.083077	1.082584	0.001103
Actuator permanent def. (mm)	1.106227	1.113553	1.113553	1.106227	1.113553	1.110623	0.004013
Sequence Number	21						
Cycle Number	496	497	498	499	500	Average	Std Dev.
Resilient Modulus (MPa)	347.529234	346.555763	344.255622	345.876458	344.239328	345.691281	1.442998
Resilient micro-strain	1277.594628	1277.594628	1289.74359	1283.699634	1289.80464	1283.687424	6.089786
Confining pressure (kPa)	50.10989	50.40293	50.40293	50.695971	50.40293	50.40293	0.207211
Maximum axial stress (kPa)	450.21999	448.976289	450.21999	450.21999	450.21999	449.97125	0.5562
Cyclic stress (kPa)	444.001482	442.757781	444.001482	444.001482	444.001482	443.752742	0.5562
Contact stress (kPa)	6.218508	6.218508	6.218508	6.218508	6.218508	6.218508	0
Permanent strain (%)	0.555788	0.555788	0.555788	0.555788	0.554567	0.555543	0.000546
Maximum load (kN)	3.53602	3.526252	3.53602	3.53602	3.53602	3.534066	0.004368
Cyclic load (kN)	3.487179	3.477411	3.487179	3.487179	3.487179	3.485226	0.004368
Contact load (kN)	0.04884	0.04884	0.04884	0.04884	0.04884	0.04884	0
Average resilient def. (mm)	0.255519	0.255519	0.257949	0.25674	0.257961	0.256737	0.001218
Axial 1 resilient def. (mm)	0.249011	0.249011	0.251429	0.249011	0.251429	0.249978	0.001324
Axial 2 resilient def. (mm)	0.262027	0.262027	0.264469	0.264469	0.264493	0.263497	0.001342
Actuator resilient def. (mm)	0.40293	0.410256	0.410256	0.410256	0.410256	0.408791	0.003276
Average permanent def. (mm)	1.111575	1.111575	1.111575	1.111575	1.109133	1.111087	0.001092
Axial 1 permanent def. (mm)	1.117875	1.117875	1.117875	1.117875	1.115458	1.117392	0.001081
Axial 2 permanent def. (mm)	1.105275	1.105275	1.105275	1.105275	1.102808	1.104781	0.001103
Actuator permanent def. (mm)	1.128205	1.120879	1.120879	1.120879	1.120879	1.122344	0.003276
Sequence Number	22						
Cycle Number	496	497	498	499	500	Average	Std Dev.
Resilient Modulus (MPa)	341.80283	343.405107	343.405107	344.369728	341.171097	342.830774	1.307602
Resilient micro-strain	1295.360195	1289.316239	1289.316239	1289.316239	1301.404151	1292.942613	5.405879
Confining pressure (kPa)	50.40293	50.40293	50.10989	50.40293	50.40293	50.344322	0.131052
Maximum axial stress (kPa)	448.976289	448.976289	448.976289	450.21999	450.21999	449.473769	0.681203
Cyclic stress (kPa)	442.757781	442.757781	442.757781	444.001482	444.001482	443.255261	0.681203
Contact stress (kPa)	6.218508	6.218508	6.218508	6.218508	6.218508	6.218508	0
Permanent strain (%)	0.56373	0.564335	0.564335	0.564335	0.56373	0.564093	0.000331
Maximum load (kN)	3.526252	3.526252	3.526252	3.53602	3.53602	3.530159	0.00535
Cyclic load (kN)	3.477411	3.477411	3.477411	3.487179	3.487179	3.481319	0.00535
Contact load (kN)	0.04884	0.04884	0.04884	0.04884	0.04884	0.04884	0
Average resilient def. (mm)	0.259072	0.257863	0.257863	0.257863	0.260281	0.258589	0.001081
Axial 1 resilient def. (mm)	0.253846	0.251429	0.251429	0.251429	0.256264	0.252879	0.002162
Axial 2 resilient def. (mm)	0.264298	0.264298	0.264298	0.264298	0.264298	0.264298	0
Actuator resilient def. (mm)	0.410256	0.410256	0.410256	0.410256	0.417582	0.411722	0.003276
Average permanent def. (mm)	1.12746	1.128669	1.128669	1.128669	1.12746	1.128186	0.000662
Axial 1 permanent def. (mm)	1.132381	1.134799	1.134799	1.134799	1.132381	1.133832	0.001324
Axial 2 permanent def. (mm)	1.12254	1.12254	1.12254	1.12254	1.12254	1.12254	0
Actuator permanent def. (mm)	1.142857	1.142857	1.142857	1.142857	1.142857	1.142857	0
Sequence Number	23						
Cycle Number	496	497	498	499	500	Average	Std Dev.
Resilient Modulus (MPa)	339.673265	343.53524	341.899512	339.673265	339.673265	340.890909	1.764776
Resilient micro-strain	1307.142857	1288.827839	1294.993895	1307.142857	1307.142857	1301.050061	8.623027
Confining pressure (kPa)	50.40293	50.40293	50.40293	50.40293	50.40293	50.40293	0
Maximum axial stress (kPa)	448.976289	448.976289	448.976289	450.21999	450.21999	449.473769	0.681203
Cyclic stress (kPa)	444.001482	442.757781	442.757781	444.001482	444.001482	443.504002	0.681203
Contact stress (kPa)	4.974807	6.218508	6.218508	6.218508	6.218508	5.969768	0.5562
Permanent strain (%)	0.571056	0.572277	0.571661	0.571056	0.571056	0.571421	0.000545
Maximum load (kN)	3.526252	3.526252	3.526252	3.53602	3.53602	3.530159	0.00535
Cyclic load (kN)	3.487179	3.477411	3.477411	3.487179	3.487179	3.483272	0.00535
Contact load (kN)	0.039072	0.04884	0.04884	0.04884	0.04884	0.046886	0.004368
Average resilient def. (mm)	0.261429	0.257766	0.258999	0.261429	0.261429	0.26021	0.001725
Axial 1 resilient def. (mm)	0.256264	0.253846	0.253846	0.256264	0.256264	0.255297	0.001324
Axial 2 resilient def. (mm)	0.266593	0.261685	0.264151	0.266593	0.266593	0.265123	0.002194
Actuator resilient def. (mm)	0.410256	0.410256	0.410256	0.424908	0.410256	0.413187	0.006553
Average permanent def. (mm)	1.142112	1.144554	1.143321	1.142112	1.142112	1.142842	0.001091
Axial 1 permanent def. (mm)	1.146886	1.149304	1.149304	1.146886	1.146886	1.147853	0.001324
Axial 2 permanent def. (mm)	1.137338	1.139805	1.137338	1.137338	1.137338	1.137832	0.001103
Actuator permanent def. (mm)	1.164835	1.164835	1.164835	1.157509	1.164835	1.16337	0.003276
Sequence Number	24						

Cycle Number	496	497	498	499	500	Average	Std Dev.
Resilient Modulus (MPa)	341.980122	342.94074	339.752606	341.331219	341.980122	341.596962	1.180215
Resilient micro-strain	1294.688645	1294.688645	1306.837607	1300.793651	1294.688645	1298.339438	5.43661
Confining pressure (kPa)	50.40293	50.40293	50.40293	50.10989	50.40293	50.344322	0.131052
Maximum axial stress (kPa)	448.976289	450.21999	450.21999	450.21999	448.976289	449.72251	0.681203
Cyclic stress (kPa)	442.757781	444.001482	444.001482	444.001482	442.757781	443.504002	0.681203
Contact stress (kPa)	6.218508	6.218508	6.218508	6.218508	6.218508	6.218508	0
Permanent strain (%)	0.577766	0.577766	0.577766	0.577766	0.577766	0.577766	0
Maximum load (kN)	3.526252	3.53602	3.53602	3.53602	3.526252	3.532112	0.00535
Cyclic load (kN)	3.477411	3.487179	3.487179	3.487179	3.477411	3.483272	0.00535
Contact load (kN)	0.04884	0.04884	0.04884	0.04884	0.04884	0.04884	0
Average resilient def. (mm)	0.258938	0.258938	0.261368	0.260159	0.258938	0.259668	0.001087
Axial 1 resilient def. (mm)	0.253846	0.253846	0.256264	0.253846	0.253846	0.25433	0.001081
Axial 2 resilient def. (mm)	0.264029	0.264029	0.266471	0.266471	0.264029	0.265006	0.001338
Actuator resilient def. (mm)	0.410256	0.410256	0.410256	0.40293	0.410256	0.408791	0.003276
Average permanent def. (mm)	1.155531	1.155531	1.155531	1.155531	1.155531	1.155531	0
Axial 1 permanent def. (mm)	1.161392	1.161392	1.161392	1.161392	1.161392	1.161392	0
Axial 2 permanent def. (mm)	1.14967	1.14967	1.14967	1.14967	1.14967	1.14967	0
Actuator permanent def. (mm)	1.172161	1.172161	1.172161	1.179487	1.172161	1.173626	0.003276
Sequence Number	25						
Cycle Number	496	497	498	499	500	Average	Std Dev.
Resilient Modulus (MPa)	343.665472	339.183151	339.800228	339.816105	339.816105	340.456212	1.814512
Resilient micro-strain	1288.339438	1312.698413	1306.654457	1306.593407	1306.593407	1304.175824	9.236594
Confining pressure (kPa)	50.40293	50.695971	50.40293	50.40293	50.40293	50.461538	0.131052
Maximum axial stress (kPa)	448.976289	451.463692	450.21999	448.976289	450.21999	449.97125	1.040555
Cyclic stress (kPa)	442.757781	445.245184	444.001482	444.001482	444.001482	444.001482	0.87943
Contact stress (kPa)	6.218508	6.218508	6.218508	4.974807	6.218508	5.969768	0.5562
Permanent strain (%)	0.583871	0.58265	0.58265	0.58265	0.58265	0.582894	0.000546
Maximum load (kN)	3.526252	3.545788	3.53602	3.526252	3.53602	3.534066	0.008173
Cyclic load (kN)	3.477411	3.496947	3.487179	3.487179	3.487179	3.487179	0.006907
Contact load (kN)	0.04884	0.04884	0.04884	0.039072	0.04884	0.046886	0.004368
Average resilient def. (mm)	0.257668	0.26254	0.261331	0.261319	0.261319	0.260835	0.001847
Axial 1 resilient def. (mm)	0.251429	0.256264	0.253846	0.256264	0.256264	0.254813	0.002162
Axial 2 resilient def. (mm)	0.263907	0.268816	0.268816	0.266374	0.266374	0.266857	0.002052
Actuator resilient def. (mm)	0.410256	0.417582	0.410256	0.417582	0.417582	0.414652	0.004013
Average permanent def. (mm)	1.167741	1.165299	1.165299	1.165299	1.165299	1.165788	0.001092
Axial 1 permanent def. (mm)	1.17348	1.171062	1.171062	1.171062	1.171062	1.171546	0.001081
Axial 2 permanent def. (mm)	1.162002	1.159536	1.159536	1.159536	1.159536	1.160029	0.001103
Actuator permanent def. (mm)	1.179487	1.179487	1.179487	1.179487	1.179487	1.179487	0
Sequence Number	26						
Cycle Number	496	497	498	499	500	Average	Std Dev.
Resilient Modulus (MPa)	336.747895	336.747895	337.691166	338.927584	338.927584	337.808425	1.091814
Resilient micro-strain	1318.498168	1318.498168	1318.498168	1306.349206	1306.349206	1313.638584	6.654261
Confining pressure (kPa)	50.40293	50.40293	50.40293	50.40293	50.40293	50.40293	0
Maximum axial stress (kPa)	450.21999	450.21999	451.463692	448.976289	448.976289	449.97125	1.040555
Cyclic stress (kPa)	444.001482	444.001482	445.245184	442.757781	442.757781	443.752742	1.040555
Contact stress (kPa)	6.218508	6.218508	6.218508	6.218508	6.218508	6.218508	0
Permanent strain (%)	0.587534	0.587534	0.587534	0.587534	0.587534	0.587534	0
Maximum load (kN)	3.53602	3.53602	3.545788	3.526252	3.526252	3.534066	0.008173
Cyclic load (kN)	3.487179	3.487179	3.496947	3.477411	3.477411	3.485226	0.008173
Contact load (kN)	0.04884	0.04884	0.04884	0.04884	0.04884	0.04884	0
Average resilient def. (mm)	0.2637	0.2637	0.2637	0.26127	0.26127	0.262728	0.001331
Axial 1 resilient def. (mm)	0.258681	0.258681	0.258681	0.256264	0.256264	0.257714	0.001324
Axial 2 resilient def. (mm)	0.268718	0.268718	0.268718	0.266276	0.266276	0.267741	0.001338
Actuator resilient def. (mm)	0.417582	0.417582	0.417582	0.410256	0.410256	0.414652	0.004013
Average permanent def. (mm)	1.175067	1.175067	1.175067	1.175067	1.175067	1.175067	0
Axial 1 permanent def. (mm)	1.180733	1.180733	1.180733	1.180733	1.180733	1.180733	0
Axial 2 permanent def. (mm)	1.169402	1.169402	1.169402	1.169402	1.169402	1.169402	0
Actuator permanent def. (mm)	1.194139	1.194139	1.194139	1.194139	1.194139	1.194139	0
Sequence Number	27						
Cycle Number	496	497	498	499	500	Average	Std Dev.
Resilient Modulus (MPa)	339.943175	339.927286	338.990953	335.851276	335.851276	338.112793	2.100165
Resilient micro-strain	1306.105006	1306.166056	1306.105006	1318.315018	1318.315018	1311.001221	6.676599
Confining pressure (kPa)	50.40293	50.695971	50.40293	50.40293	50.10989	50.40293	0.207211
Maximum axial stress (kPa)	450.21999	450.21999	448.976289	450.21999	448.976289	449.72251	0.681203
Cyclic stress (kPa)	444.001482	444.001482	442.757781	442.757781	442.757781	443.255261	0.681203
Contact stress (kPa)	6.218508	6.218508	6.218508	7.46221	6.218508	6.467248	0.5562
Permanent strain (%)	0.592418	0.591197	0.592418	0.591197	0.591197	0.591685	0.000669
Maximum load (kN)	3.53602	3.53602	3.526252	3.53602	3.526252	3.532112	0.00535
Cyclic load (kN)	3.487179	3.487179	3.477411	3.477411	3.477411	3.481319	0.00535
Contact load (kN)	0.04884	0.04884	0.04884	0.058608	0.04884	0.050794	0.004368
Average resilient def. (mm)	0.261221	0.261233	0.261221	0.263663	0.263663	0.2622	0.001335
Axial 1 resilient def. (mm)	0.256264	0.256264	0.256264	0.258681	0.258681	0.257231	0.001324
Axial 2 resilient def. (mm)	0.266178	0.266203	0.266178	0.268645	0.268645	0.26717	0.001346
Actuator resilient def. (mm)	0.410256	0.417582	0.410256	0.410256	0.410256	0.411722	0.003276

Average permanent def. (mm)	1.184835	1.182393	1.184835	1.182393	1.182393	1.18337	0.001338
Axial 1 permanent def. (mm)	1.190403	1.187985	1.190403	1.187985	1.187985	1.188952	0.001324
Axial 2 permanent def. (mm)	1.179267	1.176801	1.179267	1.176801	1.176801	1.177788	0.001351
Actuator permanent def. (mm)	1.208791	1.201465	1.208791	1.208791	1.208791	1.207326	0.003276
Sequence Number	28						
Cycle Number	496	497	498	499	500	Average	Std Dev.
Resilient Modulus (MPa)	340.566915	340.566915	338.975109	336.794678	339.927286	339.36618	1.578284
Resilient micro-strain	1300.06105	1300.06105	1306.166056	1318.315018	1306.166056	1306.153846	7.45216
Confining pressure (kPa)	50.40293	50.40293	50.40293	50.40293	50.40293	50.40293	0
Maximum axial stress (kPa)	448.976289	448.976289	450.21999	450.21999	450.21999	449.72251	0.681203
Cyclic stress (kPa)	442.757781	442.757781	442.757781	444.001482	444.001482	443.255261	0.681203
Contact stress (kPa)	6.218508	6.218508	7.46221	6.218508	6.218508	6.467248	0.5562
Permanent strain (%)	0.596667	0.596667	0.596667	0.595452	0.596056	0.596302	0.000544
Maximum load (kN)	3.526252	3.526252	3.53602	3.53602	3.53602	3.532112	0.00535
Cyclic load (kN)	3.477411	3.477411	3.477411	3.487179	3.487179	3.481319	0.00535
Contact load (kN)	0.04884	0.04884	0.058608	0.04884	0.04884	0.050794	0.004368
Average resilient def. (mm)	0.260012	0.260012	0.261233	0.263663	0.261233	0.261231	0.00149
Axial 1 resilient def. (mm)	0.253846	0.253846	0.253846	0.256264	0.253846	0.25433	0.001081
Axial 2 resilient def. (mm)	0.266178	0.266178	0.26862	0.271062	0.26862	0.268132	0.002043
Actuator resilient def. (mm)	0.410256	0.410256	0.410256	0.417582	0.410256	0.411722	0.003276
Average permanent def. (mm)	1.193333	1.193333	1.193333	1.190904	1.192112	1.192603	0.001087
Axial 1 permanent def. (mm)	1.200073	1.200073	1.200073	1.197656	1.200073	1.19959	0.001081
Axial 2 permanent def. (mm)	1.186593	1.186593	1.186593	1.184151	1.184151	1.185617	0.001338
Actuator permanent def. (mm)	1.208791	1.208791	1.208791	1.208791	1.208791	1.208791	0
Sequence Number	29						
Cycle Number	496	497	498	499	500	Average	Std Dev.
Resilient Modulus (MPa)	337.413811	337.413811	338.361602	338.361602	338.361602	337.982486	0.519127
Resilient micro-strain	1312.210012	1312.210012	1312.210012	1312.210012	1312.210012	1312.210012	0
Confining pressure (kPa)	50.40293	50.10989	50.40293	50.10989	50.40293	50.285714	0.160505
Maximum axial stress (kPa)	448.976289	448.976289	450.21999	448.976289	450.21999	449.473769	0.681203
Cyclic stress (kPa)	442.757781	442.757781	444.001482	444.001482	444.001482	443.504002	0.681203
Contact stress (kPa)	6.218508	6.218508	6.218508	4.974807	6.218508	5.969768	0.5562
Permanent strain (%)	0.599096	0.599096	0.599096	0.599096	0.599096	0.599096	0
Maximum load (kN)	3.526252	3.526252	3.53602	3.526252	3.53602	3.530159	0.00535
Cyclic load (kN)	3.477411	3.477411	3.487179	3.487179	3.487179	3.483272	0.00535
Contact load (kN)	0.04884	0.04884	0.04884	0.039072	0.04884	0.046886	0.004368
Average resilient def. (mm)	0.262442	0.262442	0.262442	0.262442	0.262442	0.262442	0
Axial 1 resilient def. (mm)	0.256264	0.256264	0.256264	0.256264	0.256264	0.256264	0
Axial 2 resilient def. (mm)	0.26862	0.26862	0.26862	0.26862	0.26862	0.26862	0
Actuator resilient def. (mm)	0.410256	0.410256	0.410256	0.410256	0.410256	0.410256	0
Average permanent def. (mm)	1.198193	1.198193	1.198193	1.198193	1.198193	1.198193	0
Axial 1 permanent def. (mm)	1.204908	1.204908	1.204908	1.204908	1.204908	1.204908	0
Axial 2 permanent def. (mm)	1.191477	1.191477	1.191477	1.191477	1.191477	1.191477	0
Actuator permanent def. (mm)	1.216117	1.216117	1.216117	1.216117	1.216117	1.216117	0
Sequence Number	30						
Cycle Number	496	497	498	499	500	Average	Std Dev.
Resilient Modulus (MPa)	338.361602	335.866829	336.196751	338.975109	337.413811	337.36282	1.341393
Resilient micro-strain	1312.210012	1318.253968	1324.358974	1306.166056	1312.210012	1314.639805	6.912609
Confining pressure (kPa)	50.40293	50.40293	50.40293	50.695971	50.40293	50.461538	0.131052
Maximum axial stress (kPa)	450.21999	448.976289	450.21999	448.976289	448.976289	449.473769	0.681203
Cyclic stress (kPa)	444.001482	442.757781	445.245184	442.757781	442.757781	443.504002	1.112401
Contact stress (kPa)	6.218508	6.218508	4.974807	6.218508	6.218508	5.969768	0.5562
Permanent strain (%)	0.602741	0.602137	0.602741	0.602741	0.602741	0.60262	0.00027
Maximum load (kN)	3.53602	3.526252	3.53602	3.526252	3.526252	3.530159	0.00535
Cyclic load (kN)	3.487179	3.477411	3.496947	3.477411	3.477411	3.483272	0.008737
Contact load (kN)	0.04884	0.04884	0.039072	0.04884	0.04884	0.046886	0.004368
Average resilient def. (mm)	0.262442	0.263651	0.264872	0.261233	0.262442	0.262928	0.001383
Axial 1 resilient def. (mm)	0.256264	0.258681	0.258681	0.253846	0.256264	0.256747	0.002023
Axial 2 resilient def. (mm)	0.26862	0.26862	0.271062	0.26862	0.26862	0.269109	0.001092
Actuator resilient def. (mm)	0.410256	0.410256	0.417582	0.417582	0.40293	0.411722	0.006129
Average permanent def. (mm)	1.205482	1.204274	1.205482	1.205482	1.205482	1.205241	0.000541
Axial 1 permanent def. (mm)	1.212161	1.209744	1.212161	1.212161	1.212161	1.211678	0.001081
Axial 2 permanent def. (mm)	1.198803	1.198803	1.198803	1.198803	1.198803	1.198803	0
Actuator permanent def. (mm)	1.230769	1.223443	1.230769	1.223443	1.230769	1.227839	0.004013
Sequence Number	31						
Cycle Number	496	497	498	499	500	Average	Std Dev.
Resilient Modulus (MPa)	341.523563	338.975109	338.361602	340.566915	337.413811	339.3682	1.663573
Resilient micro-strain	1300.06105	1306.166056	1312.210012	1300.06105	1312.210012	1306.141636	6.074496
Confining pressure (kPa)	50.40293	50.40293	50.40293	50.695971	50.695971	50.520147	0.160505
Maximum axial stress (kPa)	450.21999	448.976289	450.21999	448.976289	448.976289	449.473769	0.681203
Cyclic stress (kPa)	444.001482	442.757781	444.001482	442.757781	442.757781	443.255261	0.681203
Contact stress (kPa)	6.218508	6.218508	6.218508	6.218508	6.218508	6.218508	0
Permanent strain (%)	0.606386	0.605775	0.605171	0.606386	0.605171	0.605778	0.000607
Maximum load (kN)	3.53602	3.526252	3.53602	3.526252	3.526252	3.530159	0.00535

Cyclic load (kN)	3.487179	3.477411	3.487179	3.477411	3.477411	3.481319	0.00535
Contact load (kN)	0.04884	0.04884	0.04884	0.04884	0.04884	0.04884	0
Average resilient def. (mm)	0.260012	0.261233	0.262442	0.260012	0.262442	0.261228	0.001215
Axial 1 resilient def. (mm)	0.253846	0.253846	0.256264	0.253846	0.256264	0.254813	0.001324
Axial 2 resilient def. (mm)	0.266178	0.26862	0.26862	0.266178	0.26862	0.267643	0.001338
Actuator resilient def. (mm)	0.410256	0.410256	0.417582	0.410256	0.410256	0.411722	0.003276
Average permanent def. (mm)	1.212772	1.211551	1.210342	1.212772	1.210342	1.211556	0.001215
Axial 1 permanent def. (mm)	1.219414	1.219414	1.216996	1.219414	1.216996	1.218447	0.001324
Axial 2 permanent def. (mm)	1.206129	1.203687	1.203687	1.206129	1.203687	1.204664	0.001338
Actuator permanent def. (mm)	1.230769	1.230769	1.230769	1.230769	1.230769	1.230769	0
Sequence Number	32						
Cycle Number	496	497	498	499	500	Average	Std Dev.
Resilient Modulus (MPa)	338.990953	339.309394	340.566915	341.523563	336.794678	339.437101	1.790779
Resilient micro-strain	1306.105006	1312.210012	1300.06105	1300.06105	1318.315018	1307.350427	7.931881
Confining pressure (kPa)	50.10989	50.40293	50.10989	50.40293	50.40293	50.285714	0.160505
Maximum axial stress (kPa)	448.976289	450.21999	448.976289	450.21999	450.21999	449.72251	0.681203
Cyclic stress (kPa)	442.757781	445.245184	442.757781	444.001482	444.001482	443.752742	1.040555
Contact stress (kPa)	6.218508	4.974807	6.218508	6.218508	6.218508	5.969768	0.5562
Permanent strain (%)	0.608816	0.608816	0.608816	0.608816	0.608205	0.608694	0.000273
Maximum load (kN)	3.526252	3.53602	3.526252	3.53602	3.53602	3.532112	0.00535
Cyclic load (kN)	3.477411	3.496947	3.477411	3.487179	3.487179	3.485226	0.008173
Contact load (kN)	0.04884	0.039072	0.04884	0.04884	0.04884	0.046886	0.004368
Average resilient def. (mm)	0.261221	0.262442	0.260012	0.260012	0.263663	0.26147	0.001586
Axial 1 resilient def. (mm)	0.256264	0.256264	0.253846	0.253846	0.256264	0.255297	0.001324
Axial 2 resilient def. (mm)	0.266178	0.26862	0.266178	0.266178	0.271062	0.267643	0.002184
Actuator resilient def. (mm)	0.417582	0.410256	0.410256	0.410256	0.410256	0.411722	0.003276
Average permanent def. (mm)	1.217631	1.217631	1.217631	1.217631	1.21641	1.217387	0.000546
Axial 1 permanent def. (mm)	1.224249	1.224249	1.224249	1.224249	1.224249	1.224249	0
Axial 2 permanent def. (mm)	1.211013	1.211013	1.211013	1.211013	1.208571	1.210525	0.001092
Actuator permanent def. (mm)	1.230769	1.230769	1.230769	1.230769	1.238095	1.232234	0.003276
Sequence Number	33						
Cycle Number	496	497	498	499	500	Average	Std Dev.
Resilient Modulus (MPa)	339.943175	337.413811	338.361602	338.361602	338.990953	338.614229	0.93229
Resilient micro-strain	1306.105006	1312.210012	1312.210012	1312.210012	1306.105006	1309.76801	3.34385
Confining pressure (kPa)	50.40293	50.695971	50.40293	50.695971	50.10989	50.461538	0.245175
Maximum axial stress (kPa)	450.21999	450.21999	450.21999	450.21999	448.976289	449.97125	0.5562
Cyclic stress (kPa)	444.001482	442.757781	444.001482	444.001482	442.757781	443.504002	0.681203
Contact stress (kPa)	6.218508	7.46221	6.218508	6.218508	6.218508	6.467248	0.5562
Permanent strain (%)	0.611856	0.611245	0.611245	0.611245	0.611245	0.611368	0.000273
Maximum load (kN)	3.53602	3.53602	3.53602	3.53602	3.526252	3.534066	0.004368
Cyclic load (kN)	3.487179	3.477411	3.487179	3.487179	3.477411	3.483272	0.00535
Contact load (kN)	0.04884	0.058608	0.04884	0.04884	0.04884	0.050794	0.004368
Average resilient def. (mm)	0.261221	0.262442	0.262442	0.262442	0.261221	0.261954	0.000669
Axial 1 resilient def. (mm)	0.256264	0.256264	0.256264	0.256264	0.256264	0.256264	0
Axial 2 resilient def. (mm)	0.266178	0.26862	0.26862	0.26862	0.266178	0.267643	0.001338
Actuator resilient def. (mm)	0.410256	0.410256	0.417582	0.410256	0.40293	0.410256	0.00518
Average permanent def. (mm)	1.223712	1.222491	1.222491	1.222491	1.222491	1.222735	0.000546
Axial 1 permanent def. (mm)	1.229084	1.229084	1.229084	1.229084	1.229084	1.229084	0
Axial 2 permanent def. (mm)	1.218339	1.215897	1.215897	1.215897	1.215897	1.216386	0.001092
Actuator permanent def. (mm)	1.245421	1.245421	1.238095	1.245421	1.245421	1.243956	0.003276
Sequence Number	34						
Cycle Number	496	497	498	499	500	Average	Std Dev.
Resilient Modulus (MPa)	337.429509	335.273109	337.429509	337.429509	336.825874	336.877502	0.934195
Resilient micro-strain	1312.148962	1324.297924	1312.148962	1312.148962	1318.192918	1315.787546	5.429784
Confining pressure (kPa)	50.40293	50.40293	50.40293	50.10989	50.40293	50.344322	0.131052
Maximum axial stress (kPa)	448.976289	450.21999	448.976289	448.976289	450.21999	449.473769	0.681203
Cyclic stress (kPa)	442.757781	444.001482	442.757781	442.757781	444.001482	443.255261	0.681203
Contact stress (kPa)	6.218508	6.218508	6.218508	6.218508	6.218508	6.218508	0
Permanent strain (%)	0.613071	0.613071	0.613681	0.613071	0.613071	0.613193	0.000273
Maximum load (kN)	3.526252	3.53602	3.526252	3.526252	3.53602	3.530159	0.00535
Cyclic load (kN)	3.477411	3.487179	3.477411	3.477411	3.487179	3.481319	0.00535
Contact load (kN)	0.04884	0.04884	0.04884	0.04884	0.04884	0.04884	0
Average resilient def. (mm)	0.26243	0.26486	0.26243	0.26243	0.263639	0.263158	0.001086
Axial 1 resilient def. (mm)	0.258681	0.261099	0.258681	0.258681	0.261099	0.259648	0.001324
Axial 2 resilient def. (mm)	0.266178	0.26862	0.266178	0.266178	0.266178	0.266667	0.001092
Actuator resilient def. (mm)	0.410256	0.417582	0.410256	0.410256	0.417582	0.413187	0.004013
Average permanent def. (mm)	1.226142	1.226142	1.227363	1.226142	1.226142	1.226386	0.000546
Axial 1 permanent def. (mm)	1.231502	1.231502	1.231502	1.231502	1.231502	1.231502	0
Axial 2 permanent def. (mm)	1.220781	1.220781	1.223223	1.220781	1.220781	1.22127	0.001092
Actuator permanent def. (mm)	1.252747	1.252747	1.252747	1.252747	1.252747	1.252747	0
Sequence Number	35						
Cycle Number	496	497	498	499	500	Average	Std Dev.
Resilient Modulus (MPa)	338.345861	338.975109	337.722441	337.398113	339.927286	338.473762	1.012663
Resilient micro-strain	1312.271062	1306.166056	1318.376068	1312.271062	1306.166056	1311.050061	5.107815

Confining pressure (kPa)	50.10989	50.40293	50.40293	50.40293	50.40293	50.344322	0.131052
Maximum axial stress (kPa)	450.21999	448.976289	451.463692	448.976289	450.21999	449.97125	1.040555
Cyclic stress (kPa)	444.001482	442.757781	445.245184	442.757781	444.001482	443.752742	1.040555
Contact stress (kPa)	6.218508	6.218508	6.218508	6.218508	6.218508	6.218508	0
Permanent strain (%)	0.616105	0.616105	0.616105	0.616105	0.616105	0.616105	0
Maximum load (kN)	3.53602	3.526252	3.545788	3.526252	3.53602	3.534066	0.008173
Cyclic load (kN)	3.487179	3.477411	3.496947	3.477411	3.487179	3.485226	0.008173
Contact load (kN)	0.04884	0.04884	0.04884	0.04884	0.04884	0.04884	0
Average resilient def. (mm)	0.262454	0.261233	0.263675	0.262454	0.261233	0.26221	0.001022
Axial 1 resilient def. (mm)	0.256288	0.256288	0.25873	0.256288	0.256288	0.256777	0.001092
Axial 2 resilient def. (mm)	0.26862	0.266178	0.26862	0.26862	0.266178	0.267643	0.001338
Actuator resilient def. (mm)	0.417582	0.40293	0.410256	0.410256	0.410256	0.410256	0.00518
Average permanent def. (mm)	1.23221	1.23221	1.23221	1.23221	1.23221	1.23221	0
Axial 1 permanent def. (mm)	1.238755	1.238755	1.238755	1.238755	1.238755	1.238755	0
Axial 2 permanent def. (mm)	1.225665	1.225665	1.225665	1.225665	1.225665	1.225665	0
Actuator permanent def. (mm)	1.245421	1.252747	1.252747	1.245421	1.245421	1.248352	0.004013
Sequence Number	36						
Cycle Number	496	497	498	499	500	Average	Std Dev.
Resilient Modulus (MPa)	339.895512	337.366723	337.366723	338.943424	338.959266	338.50633	1.109441
Resilient micro-strain	1306.288156	1312.393162	1312.393162	1306.288156	1306.227106	1308.717949	3.355088
Confining pressure (kPa)	50.40293	50.40293	50.40293	50.40293	50.40293	50.40293	0
Maximum axial stress (kPa)	448.976289	448.976289	448.976289	448.976289	448.976289	448.976289	0
Cyclic stress (kPa)	444.001482	442.757781	442.757781	442.757781	442.757781	443.006521	0.5562
Contact stress (kPa)	4.974807	6.218508	6.218508	6.218508	6.218508	5.969768	0.5562
Permanent strain (%)	0.618535	0.618535	0.618535	0.618535	0.61793	0.618414	0.00027
Maximum load (kN)	3.526252	3.526252	3.526252	3.526252	3.526252	3.526252	0
Cyclic load (kN)	3.487179	3.477411	3.477411	3.477411	3.477411	3.479365	0.004368
Contact load (kN)	0.039072	0.04884	0.04884	0.04884	0.04884	0.046886	0.004368
Average resilient def. (mm)	0.261258	0.262479	0.262479	0.261258	0.261245	0.261744	0.000671
Axial 1 resilient def. (mm)	0.256337	0.256337	0.256337	0.256337	0.256313	0.256332	0.000011
Axial 2 resilient def. (mm)	0.266178	0.26862	0.26862	0.266178	0.266178	0.267155	0.001338
Actuator resilient def. (mm)	0.417582	0.417582	0.417582	0.410256	0.410256	0.414652	0.004013
Average permanent def. (mm)	1.23707	1.23707	1.23707	1.23707	1.235861	1.236828	0.000541
Axial 1 permanent def. (mm)	1.24359	1.24359	1.24359	1.24359	1.241172	1.243106	0.001081
Axial 2 permanent def. (mm)	1.230549	1.230549	1.230549	1.230549	1.230549	1.230549	0
Actuator permanent def. (mm)	1.252747	1.252747	1.252747	1.252747	1.252747	1.252747	0
Sequence Number	37						
Cycle Number	496	497	498	499	500	Average	Std Dev.
Resilient Modulus (MPa)	336.119279	338.298645	339.863745	338.298645	340.193876	338.554838	1.61732
Resilient micro-strain	1324.664225	1312.454212	1306.410256	1312.454212	1312.454212	1313.687424	6.671015
Confining pressure (kPa)	50.40293	50.40293	50.40293	50.40293	50.10989	50.344322	0.131052
Maximum axial stress (kPa)	451.463692	450.21999	450.21999	450.21999	451.463692	450.717471	0.681203
Cyclic stress (kPa)	445.245184	444.001482	444.001482	444.001482	446.488886	444.747703	1.112401
Contact stress (kPa)	6.218508	6.218508	6.218508	6.218508	4.974807	5.969768	0.5562
Permanent strain (%)	0.62036	0.62036	0.620965	0.62036	0.62036	0.620481	0.00027
Maximum load (kN)	3.545788	3.53602	3.53602	3.53602	3.545788	3.539927	0.00535
Cyclic load (kN)	3.496947	3.487179	3.487179	3.487179	3.506716	3.49304	0.008737
Contact load (kN)	0.04884	0.04884	0.04884	0.04884	0.039072	0.046886	0.004368
Average resilient def. (mm)	0.264933	0.262491	0.261282	0.262491	0.262491	0.262737	0.001334
Axial 1 resilient def. (mm)	0.261245	0.258803	0.256386	0.258803	0.258803	0.258808	0.001718
Axial 2 resilient def. (mm)	0.26862	0.266178	0.266178	0.266178	0.266178	0.266667	0.001092
Actuator resilient def. (mm)	0.424908	0.40293	0.40293	0.417582	0.417582	0.413187	0.009829
Average permanent def. (mm)	1.24072	1.24072	1.241929	1.24072	1.24072	1.240962	0.000541
Axial 1 permanent def. (mm)	1.246007	1.246007	1.248425	1.246007	1.246007	1.246491	0.001081
Axial 2 permanent def. (mm)	1.235433	1.235433	1.235433	1.235433	1.235433	1.235433	0
Actuator permanent def. (mm)	1.260073	1.267399	1.267399	1.260073	1.260073	1.263004	0.004013
Sequence Number	38						
Cycle Number	496	497	498	499	500	Average	Std Dev.
Resilient Modulus (MPa)	342.076904	338.895909	336.701124	338.895909	336.701124	338.654194	2.205718
Resilient micro-strain	1294.322344	1306.471306	1318.681319	1306.471306	1318.681319	1308.925519	10.193752
Confining pressure (kPa)	50.989011	50.695971	50.40293	50.10989	50.40293	50.520147	0.334117
Maximum axial stress (kPa)	448.976289	448.976289	450.21999	448.976289	450.21999	449.473769	0.681203
Cyclic stress (kPa)	442.757781	442.757781	444.001482	442.757781	444.001482	443.255261	0.681203
Contact stress (kPa)	6.218508	6.218508	6.218508	6.218508	6.218508	6.218508	0
Permanent strain (%)	0.623394	0.622179	0.622179	0.622179	0.622179	0.622422	0.000543
Maximum load (kN)	3.526252	3.526252	3.53602	3.526252	3.53602	3.530159	0.00535
Cyclic load (kN)	3.477411	3.477411	3.487179	3.477411	3.487179	3.481319	0.00535
Contact load (kN)	0.04884	0.04884	0.04884	0.04884	0.04884	0.04884	0
Average resilient def. (mm)	0.258864	0.261294	0.263736	0.261294	0.263736	0.261785	0.002039
Axial 1 resilient def. (mm)	0.253993	0.25641	0.258852	0.25641	0.258852	0.256904	0.002034
Axial 2 resilient def. (mm)	0.263736	0.266178	0.26862	0.266178	0.26862	0.266667	0.002043
Actuator resilient def. (mm)	0.40293	0.410256	0.417582	0.410256	0.410256	0.410256	0.00518
Average permanent def. (mm)	1.246789	1.244359	1.244359	1.244359	1.244359	1.244845	0.001087
Axial 1 permanent def. (mm)	1.25326	1.250842	1.250842	1.250842	1.250842	1.251326	0.001081
Axial 2 permanent def. (mm)	1.240317	1.237875	1.237875	1.237875	1.237875	1.238364	0.001092

Actuator permanent def. (mm)	1.267399	1.260073	1.267399	1.260073	1.267399	1.264469	0.004013
Sequence Number	39						
Cycle Number	496	497	498	499	500	Average	Std Dev.
Resilient Modulus (MPa)	339.816105	340.455002	340.455002	339.816105	338.864239	339.881291	0.652147
Resilient micro-strain	1306.593407	1300.4884	1300.4884	1306.593407	1306.593407	1304.151404	3.34385
Confining pressure (kPa)	50.40293	50.40293	50.40293	50.40293	50.10989	50.344322	0.131052
Maximum axial stress (kPa)	450.21999	448.976289	448.976289	450.21999	448.976289	449.473769	0.681203
Cyclic stress (kPa)	444.001482	442.757781	442.757781	444.001482	442.757781	443.255261	0.681203
Contact stress (kPa)	6.218508	6.218508	6.218508	6.218508	6.218508	6.218508	0
Permanent strain (%)	0.624609	0.624609	0.624609	0.624609	0.624609	0.624609	0
Maximum load (kN)	3.53602	3.526252	3.526252	3.53602	3.526252	3.530159	0.00535
Cyclic load (kN)	3.487179	3.477411	3.477411	3.487179	3.477411	3.481319	0.00535
Contact load (kN)	0.04884	0.04884	0.04884	0.04884	0.04884	0.04884	0
Average resilient def. (mm)	0.261319	0.260098	0.260098	0.261319	0.261319	0.26083	0.000669
Axial 1 resilient def. (mm)	0.256459	0.256459	0.256459	0.256459	0.256459	0.256459	0
Axial 2 resilient def. (mm)	0.266178	0.263736	0.263736	0.266178	0.266178	0.265201	0.001338
Actuator resilient def. (mm)	0.410256	0.40293	0.40293	0.410256	0.410256	0.407326	0.004013
Average permanent def. (mm)	1.249219	1.249219	1.249219	1.249219	1.249219	1.249219	0
Axial 1 permanent def. (mm)	1.255678	1.255678	1.255678	1.255678	1.255678	1.255678	0
Axial 2 permanent def. (mm)	1.242759	1.242759	1.242759	1.242759	1.242759	1.242759	0
Actuator permanent def. (mm)	1.267399	1.267399	1.267399	1.267399	1.267399	1.267399	0
Sequence Number	40						
Cycle Number	496	497	498	499	500	Average	Std Dev.
Resilient Modulus (MPa)	375.379107	372.092175	374.520116	369.841733	373.802943	373.127215	2.198494
Resilient micro-strain	1447.863248	1453.968254	1447.863248	1466.178266	1453.968254	1453.968254	7.477075
Confining pressure (kPa)	50.10989	50.40293	50.40293	50.40293	50.40293	50.344322	0.131052
Maximum axial stress (kPa)	549.716121	548.472419	549.716121	549.716121	550.959823	549.716121	0.87943
Cyclic stress (kPa)	543.497613	541.010209	542.253911	542.253911	543.497613	542.502651	1.040555
Contact stress (kPa)	6.218508	7.46221	7.46221	7.46221	7.46221	7.213469	0.5562
Permanent strain (%)	0.641618	0.641618	0.641618	0.641618	0.641618	0.641618	0
Maximum load (kN)	4.31746	4.307692	4.31746	4.31746	4.327228	4.31746	0.006907
Cyclic load (kN)	4.26862	4.249084	4.258852	4.258852	4.26862	4.260806	0.008173
Contact load (kN)	0.04884	0.058608	0.058608	0.058608	0.058608	0.056654	0.004368
Average resilient def. (mm)	0.289573	0.290794	0.289573	0.293236	0.290794	0.290794	0.001495
Axial 1 resilient def. (mm)	0.281221	0.283663	0.281221	0.286105	0.283663	0.283175	0.002043
Axial 2 resilient def. (mm)	0.297924	0.297924	0.297924	0.300366	0.297924	0.298413	0.001092
Actuator resilient def. (mm)	0.468864	0.468864	0.468864	0.468864	0.47619	0.47033	0.003276
Average permanent def. (mm)	1.283236	1.283236	1.283236	1.283236	1.283236	1.283236	0
Axial 1 permanent def. (mm)	1.289524	1.289524	1.289524	1.289524	1.289524	1.289524	0
Axial 2 permanent def. (mm)	1.276947	1.276947	1.276947	1.276947	1.276947	1.276947	0
Actuator permanent def. (mm)	1.304029	1.304029	1.304029	1.304029	1.304029	1.304029	0
Sequence Number	41						
Cycle Number	496	497	498	499	500	Average	Std Dev.
Resilient Modulus (MPa)	368.170738	370.535707	368.855244	372.084381	368.855244	369.700263	1.592918
Resilient micro-strain	1472.832723	1466.788767	1466.727717	1460.683761	1466.727717	1466.752137	4.295383
Confining pressure (kPa)	50.40293	50.40293	50.40293	50.695971	50.10989	50.40293	0.207211
Maximum axial stress (kPa)	549.716121	550.959823	548.472419	549.716121	548.472419	549.467381	1.040555
Cyclic stress (kPa)	542.253911	543.497613	541.010209	543.497613	541.010209	542.253911	1.243702
Contact stress (kPa)	7.46221	7.46221	7.46221	6.218508	7.46221	7.213469	0.5562
Permanent strain (%)	0.652552	0.653767	0.652552	0.653767	0.652552	0.653038	0.000665
Maximum load (kN)	4.31746	4.327228	4.307692	4.31746	4.307692	4.315507	0.008173
Cyclic load (kN)	4.258852	4.26862	4.249084	4.26862	4.249084	4.258852	0.009768
Contact load (kN)	0.058608	0.058608	0.058608	0.04884	0.058608	0.056654	0.004368
Average resilient def. (mm)	0.294567	0.293358	0.293346	0.292137	0.293346	0.29335	0.000859
Axial 1 resilient def. (mm)	0.288767	0.286349	0.286325	0.286349	0.286325	0.286823	0.001087
Axial 2 resilient def. (mm)	0.300366	0.300366	0.300366	0.297924	0.300366	0.299878	0.001092
Actuator resilient def. (mm)	0.47619	0.47619	0.468864	0.468864	0.468864	0.471795	0.004013
Average permanent def. (mm)	1.305104	1.307534	1.305104	1.307534	1.305104	1.306076	0.001331
Axial 1 permanent def. (mm)	1.311282	1.3137	1.311282	1.3137	1.311282	1.312249	0.001324
Axial 2 permanent def. (mm)	1.298926	1.301368	1.298926	1.301368	1.298926	1.299902	0.001338
Actuator permanent def. (mm)	1.333333	1.333333	1.333333	1.333333	1.333333	1.333333	0
Sequence Number	42						
Cycle Number	496	497	498	499	500	Average	Std Dev.
Resilient Modulus (MPa)	372.634631	369.549368	371.093339	368.701778	372.634631	370.922749	1.782489
Resilient micro-strain	1455.189255	1467.338217	1461.233211	1467.338217	1455.189255	1461.257631	6.074496
Confining pressure (kPa)	50.40293	50.40293	50.40293	50.40293	50.40293	50.40293	0
Maximum axial stress (kPa)	549.716121	549.716121	549.716121	548.472419	549.716121	549.467381	0.5562
Cyclic stress (kPa)	542.253911	542.253911	542.253911	541.010209	542.253911	542.005171	0.5562
Contact stress (kPa)	7.46221	7.46221	7.46221	7.46221	7.46221	7.46221	0
Permanent strain (%)	0.664695	0.66348	0.66409	0.66348	0.664695	0.664088	0.000607
Maximum load (kN)	4.31746	4.31746	4.31746	4.307692	4.31746	4.315507	0.004368
Cyclic load (kN)	4.258852	4.258852	4.258852	4.249084	4.258852	4.256899	0.004368
Contact load (kN)	0.058608	0.058608	0.058608	0.058608	0.058608	0.058608	0
Average resilient def. (mm)	0.291038	0.293468	0.292247	0.293468	0.291038	0.292252	0.001215

Axial 1 resilient def. (mm)	0.281709	0.284127	0.284127	0.284127	0.281709	0.28316	0.001324
Axial 2 resilient def. (mm)	0.300366	0.302808	0.300366	0.302808	0.300366	0.301343	0.001338
Actuator resilient def. (mm)	0.468864	0.468864	0.468864	0.461538	0.468864	0.467399	0.003276
Average permanent def. (mm)	1.329389	1.32696	1.328181	1.32696	1.329389	1.328176	0.001215
Axial 1 permanent def. (mm)	1.337875	1.335458	1.335458	1.335458	1.337875	1.336425	0.001324
Axial 2 permanent def. (mm)	1.320904	1.318462	1.320904	1.318462	1.320904	1.319927	0.001338
Actuator permanent def. (mm)	1.347985	1.347985	1.347985	1.347985	1.347985	1.347985	0
Sequence Number	43						
Cycle Number	496	497	498	499	500	Average	Std Dev.
Resilient Modulus (MPa)	364.873642	367.219028	368.563768	364.873642	363.560393	365.818095	2.023767
Resilient micro-strain	1486.141636	1480.03663	1467.887668	1486.141636	1498.351648	1483.711844	11.068462
Confining pressure (kPa)	50.40293	50.40293	50.10989	50.40293	50.40293	50.344322	0.131052
Maximum axial stress (kPa)	549.716121	549.716121	548.472419	549.716121	552.203524	549.964861	1.362407
Cyclic stress (kPa)	542.253911	543.497613	541.010209	542.253911	544.741314	542.751392	1.418038
Contact stress (kPa)	7.46221	6.218508	7.46221	7.46221	7.46221	7.213469	0.5562
Permanent strain (%)	0.673199	0.673199	0.674414	0.673199	0.673199	0.673442	0.000543
Maximum load (kN)	4.31746	4.31746	4.307692	4.31746	4.336996	4.319414	0.0107
Cyclic load (kN)	4.258852	4.26862	4.249084	4.258852	4.278388	4.262759	0.011137
Contact load (kN)	0.058608	0.04884	0.058608	0.058608	0.058608	0.056654	0.004368
Average resilient def. (mm)	0.297228	0.296007	0.293578	0.297228	0.29967	0.296742	0.002214
Axial 1 resilient def. (mm)	0.289206	0.286764	0.284347	0.289206	0.291648	0.288234	0.002776
Axial 2 resilient def. (mm)	0.30525	0.30525	0.302808	0.30525	0.307692	0.30525	0.001727
Actuator resilient def. (mm)	0.483516	0.468864	0.468864	0.483516	0.483516	0.477656	0.008025
Average permanent def. (mm)	1.346398	1.346398	1.348828	1.346398	1.346398	1.346884	0.001087
Axial 1 permanent def. (mm)	1.354799	1.354799	1.357216	1.354799	1.354799	1.355282	0.001081
Axial 2 permanent def. (mm)	1.337998	1.337998	1.34044	1.337998	1.337998	1.338486	0.001092
Actuator permanent def. (mm)	1.362637	1.369963	1.369963	1.362637	1.369963	1.367033	0.004013
Sequence Number	44						
Cycle Number	496	497	498	499	500	Average	Std Dev.
Resilient Modulus (MPa)	364.76875	366.272951	365.432876	364.76875	365.605376	365.36974	0.631997
Resilient micro-strain	1486.568987	1480.46398	1480.46398	1486.568987	1486.568987	1484.126984	3.34385
Confining pressure (kPa)	50.40293	50.10989	50.40293	50.40293	50.40293	50.344322	0.131052
Maximum axial stress (kPa)	549.716121	549.716121	548.472419	549.716121	550.959823	549.716121	0.87943
Cyclic stress (kPa)	542.253911	542.253911	541.010209	542.253911	543.497613	542.253911	0.87943
Contact stress (kPa)	7.46221	7.46221	7.46221	7.46221	7.46221	7.46221	0
Permanent strain (%)	0.681703	0.682314	0.682314	0.682314	0.682314	0.682192	0.000273
Maximum load (kN)	4.31746	4.31746	4.307692	4.31746	4.327228	4.31746	0.006907
Cyclic load (kN)	4.258852	4.258852	4.249084	4.258852	4.26862	4.258852	0.006907
Contact load (kN)	0.058608	0.058608	0.058608	0.058608	0.058608	0.058608	0
Average resilient def. (mm)	0.297314	0.296093	0.296093	0.297314	0.297314	0.296825	0.000669
Axial 1 resilient def. (mm)	0.289377	0.289377	0.289377	0.291819	0.291819	0.290354	0.001338
Axial 2 resilient def. (mm)	0.30525	0.302808	0.302808	0.302808	0.302808	0.303297	0.001092
Actuator resilient def. (mm)	0.468864	0.468864	0.468864	0.47619	0.47619	0.471795	0.004013
Average permanent def. (mm)	1.363407	1.364628	1.364628	1.364628	1.364628	1.364383	0.000546
Axial 1 permanent def. (mm)	1.371722	1.371722	1.371722	1.371722	1.371722	1.371722	0
Axial 2 permanent def. (mm)	1.355092	1.357534	1.357534	1.357534	1.357534	1.357045	0.001092
Actuator permanent def. (mm)	1.391941	1.391941	1.391941	1.391941	1.391941	1.391941	0
Sequence Number	45						
Cycle Number	496	497	498	499	500	Average	Std Dev.
Resilient Modulus (MPa)	363.767794	363.767794	364.604042	363.113489	363.767794	363.804183	0.52934
Resilient micro-strain	1487.240537	1487.240537	1487.240537	1493.345543	1487.240537	1488.461538	2.730242
Confining pressure (kPa)	50.40293	50.40293	50.695971	50.695971	50.40293	50.520147	0.160505
Maximum axial stress (kPa)	548.472419	548.472419	549.716121	549.716121	548.472419	548.9699	0.681203
Cyclic stress (kPa)	541.010209	541.010209	542.253911	542.253911	541.010209	541.50769	0.681203
Contact stress (kPa)	7.46221	7.46221	7.46221	7.46221	7.46221	7.46221	0
Permanent strain (%)	0.690208	0.690208	0.690208	0.690208	0.690208	0.690208	0
Maximum load (kN)	4.307692	4.307692	4.31746	4.31746	4.307692	4.3116	0.00535
Cyclic load (kN)	4.249084	4.249084	4.258852	4.258852	4.249084	4.252991	0.00535
Contact load (kN)	0.058608	0.058608	0.058608	0.058608	0.058608	0.058608	0
Average resilient def. (mm)	0.297448	0.297448	0.297448	0.298669	0.297448	0.297692	0.000546
Axial 1 resilient def. (mm)	0.289548	0.289548	0.289548	0.29199	0.289548	0.290037	0.001092
Axial 2 resilient def. (mm)	0.305348	0.305348	0.305348	0.305348	0.305348	0.305348	0
Actuator resilient def. (mm)	0.47619	0.468864	0.468864	0.47619	0.468864	0.471795	0.004013
Average permanent def. (mm)	1.380415	1.380415	1.380415	1.380415	1.380415	1.380415	0
Axial 1 permanent def. (mm)	1.388645	1.388645	1.388645	1.388645	1.388645	1.388645	0
Axial 2 permanent def. (mm)	1.372186	1.372186	1.372186	1.372186	1.372186	1.372186	0
Actuator permanent def. (mm)	1.399267	1.406593	1.406593	1.406593	1.406593	1.405128	0.003276
Sequence Number	46						
Cycle Number	496	497	498	499	500	Average	Std Dev.
Resilient Modulus (MPa)	363.738137	364.379679	362.073431	362.073431	363.738137	363.200563	1.061737
Resilient micro-strain	1494.200244	1488.156288	1494.200244	1494.200244	1494.200244	1492.991453	2.702939
Confining pressure (kPa)	50.40293	50.40293	50.40293	50.695971	50.40293	50.461538	0.131052
Maximum axial stress (kPa)	549.716121	549.716121	548.472419	548.472419	549.716121	549.21864	0.681203
Cyclic stress (kPa)	543.497613	542.253911	541.010209	541.010209	543.497613	542.253911	1.243702

Contact stress (kPa)	6.218508	7.46221	7.46221	7.46221	6.218508	6.964729	0.681203
Permanent strain (%)	0.698101	0.698706	0.698101	0.698101	0.698101	0.698222	0.00027
Maximum load (kN)	4.31746	4.31746	4.307692	4.307692	4.31746	4.313553	0.00535
Cyclic load (kN)	4.26862	4.258852	4.249084	4.249084	4.26862	4.258852	0.009768
Contact load (kN)	0.04884	0.058608	0.058608	0.058608	0.04884	0.054701	0.00535
Average resilient def. (mm)	0.29884	0.297631	0.29884	0.29884	0.29884	0.298598	0.000541
Axial 1 resilient def. (mm)	0.289719	0.287302	0.289719	0.289719	0.289719	0.289236	0.001081
Axial 2 resilient def. (mm)	0.307961	0.307961	0.307961	0.307961	0.307961	0.307961	0
Actuator resilient def. (mm)	0.47619	0.468864	0.47619	0.47619	0.47619	0.474725	0.003276
Average permanent def. (mm)	1.396203	1.397411	1.396203	1.396203	1.396203	1.396444	0.000541
Axial 1 permanent def. (mm)	1.405568	1.407985	1.405568	1.405568	1.405568	1.406051	0.001081
Axial 2 permanent def. (mm)	1.386838	1.386838	1.386838	1.386838	1.386838	1.386838	0
Actuator permanent def. (mm)	1.413919	1.421245	1.413919	1.413919	1.413919	1.415385	0.003276
Sequence Number	47						
Cycle Number	496	497	498	499	500	Average	Std Dev.
Resilient Modulus (MPa)	358.323345	359.774751	361.895995	361.252656	360.424095	360.334169	1.382694
Resilient micro-strain	1513.308913	1507.203907	1494.932845	1501.037851	1501.037851	1503.504274	6.990245
Confining pressure (kPa)	50.40293	50.40293	50.40293	50.40293	50.695971	50.461538	0.131052
Maximum axial stress (kPa)	549.716121	549.716121	548.472419	549.716121	548.472419	549.21864	0.681203
Cyclic stress (kPa)	542.253911	542.253911	541.010209	542.253911	541.010209	541.75643	0.681203
Contact stress (kPa)	7.46221	7.46221	7.46221	7.46221	7.46221	7.46221	0
Permanent strain (%)	0.705391	0.706001	0.706001	0.705391	0.705391	0.705635	0.000334
Maximum load (kN)	4.31746	4.31746	4.307692	4.31746	4.307692	4.313553	0.00535
Cyclic load (kN)	4.258852	4.258852	4.249084	4.258852	4.249084	4.254945	0.00535
Contact load (kN)	0.058608	0.058608	0.058608	0.058608	0.058608	0.058608	0
Average resilient def. (mm)	0.302662	0.301441	0.298987	0.300208	0.300208	0.300701	0.001398
Axial 1 resilient def. (mm)	0.29475	0.29475	0.292308	0.292308	0.292308	0.293284	0.001338
Axial 2 resilient def. (mm)	0.310574	0.308132	0.305665	0.308107	0.308107	0.308117	0.001735
Actuator resilient def. (mm)	0.47619	0.47619	0.468864	0.468864	0.47619	0.47326	0.004013
Average permanent def. (mm)	1.410781	1.412002	1.412002	1.410781	1.410781	1.41127	0.000669
Axial 1 permanent def. (mm)	1.420073	1.420073	1.420073	1.420073	1.420073	1.420073	0
Axial 2 permanent def. (mm)	1.40149	1.403932	1.403932	1.40149	1.40149	1.402466	0.001338
Actuator permanent def. (mm)	1.435897	1.435897	1.435897	1.435897	1.435897	1.435897	0
Sequence Number	48						
Cycle Number	496	497	498	499	500	Average	Std Dev.
Resilient Modulus (MPa)	360.248272	358.789717	360.248272	355.270552	358.804245	358.672211	2.035341
Resilient micro-strain	1501.770452	1507.875458	1501.770452	1526.312576	1507.814408	1509.108669	10.0855
Confining pressure (kPa)	50.10989	50.40293	50.40293	50.40293	50.40293	50.344322	0.131052
Maximum axial stress (kPa)	548.472419	548.472419	548.472419	549.716121	548.472419	548.72116	0.5562
Cyclic stress (kPa)	541.010209	541.010209	541.010209	542.253911	541.010209	541.25895	0.5562
Contact stress (kPa)	7.46221	7.46221	7.46221	7.46221	7.46221	7.46221	0
Permanent strain (%)	0.713291	0.71268	0.713291	0.71268	0.712076	0.712803	0.000509
Maximum load (kN)	4.307692	4.307692	4.307692	4.31746	4.307692	4.309646	0.004368
Cyclic load (kN)	4.249084	4.249084	4.249084	4.258852	4.249084	4.251038	0.004368
Contact load (kN)	0.058608	0.058608	0.058608	0.058608	0.058608	0.058608	0
Average resilient def. (mm)	0.300354	0.301575	0.300354	0.305263	0.301563	0.301822	0.002017
Axial 1 resilient def. (mm)	0.294896	0.294896	0.294896	0.297338	0.294872	0.29538	0.001095
Axial 2 resilient def. (mm)	0.305812	0.308254	0.305812	0.313187	0.308254	0.308264	0.003011
Actuator resilient def. (mm)	0.468864	0.47619	0.47619	0.483516	0.468864	0.474725	0.006129
Average permanent def. (mm)	1.426581	1.42536	1.426581	1.42536	1.424151	1.425607	0.001017
Axial 1 permanent def. (mm)	1.434579	1.434579	1.434579	1.434579	1.432161	1.434095	0.001081
Axial 2 permanent def. (mm)	1.418584	1.416142	1.418584	1.416142	1.416142	1.417118	0.001338
Actuator permanent def. (mm)	1.457875	1.450549	1.457875	1.450549	1.457875	1.454945	0.004013
Sequence Number	49						
Cycle Number	496	497	498	499	500	Average	Std Dev.
Resilient Modulus (MPa)	358.034467	359.468982	358.855647	360.293452	358.673543	359.065218	0.856061
Resilient micro-strain	1514.529915	1508.485958	1514.529915	1508.485958	1508.363858	1510.879121	3.333076
Confining pressure (kPa)	50.40293	50.10989	50.40293	50.10989	50.40293	50.285714	0.160505
Maximum axial stress (kPa)	549.716121	549.716121	550.959823	550.959823	548.472419	549.964861	1.040555
Cyclic stress (kPa)	542.253911	542.253911	543.497613	543.497613	541.010209	542.502651	1.040555
Contact stress (kPa)	7.46221	7.46221	7.46221	7.46221	7.46221	7.46221	0
Permanent strain (%)	0.719359	0.719359	0.719359	0.719359	0.719359	0.719359	0
Maximum load (kN)	4.31746	4.31746	4.327228	4.327228	4.307692	4.319414	0.008173
Cyclic load (kN)	4.258852	4.258852	4.26862	4.26862	4.249084	4.260806	0.008173
Contact load (kN)	0.058608	0.058608	0.058608	0.058608	0.058608	0.058608	0
Average resilient def. (mm)	0.302906	0.301697	0.302906	0.301697	0.301673	0.302176	0.000667
Axial 1 resilient def. (mm)	0.294969	0.292552	0.294969	0.292552	0.294969	0.294002	0.001324
Axial 2 resilient def. (mm)	0.310842	0.310842	0.310842	0.310842	0.308376	0.310349	0.001103
Actuator resilient def. (mm)	0.483516	0.483516	0.483516	0.483516	0.483516	0.483516	0
Average permanent def. (mm)	1.438718	1.438718	1.438718	1.438718	1.438718	1.438718	0
Axial 1 permanent def. (mm)	1.449084	1.449084	1.449084	1.449084	1.449084	1.449084	0
Axial 2 permanent def. (mm)	1.428352	1.428352	1.428352	1.428352	1.428352	1.428352	0
Actuator permanent def. (mm)	1.457875	1.457875	1.457875	1.457875	1.457875	1.457875	0
Sequence Number	50						

Cycle Number	496	497	498	499	500	Average	Std Dev.
Resilient Modulus (MPa)	357.962321	359.60435	358.586462	360.028733	358.600972	358.956568	0.839808
Resilient micro-strain	1514.835165	1514.835165	1508.730159	1502.686203	1508.669109	1509.95116	5.089723
Confining pressure (kPa)	50.695971	50.10989	50.695971	50.40293	50.40293	50.461538	0.245175
Maximum axial stress (kPa)	549.716121	550.959823	548.472419	548.472419	548.472419	549.21864	1.112401
Cyclic stress (kPa)	542.253911	544.741314	541.010209	541.010209	541.010209	542.005171	1.621589
Contact stress (kPa)	7.46221	6.218508	7.46221	7.46221	7.46221	7.213469	0.5562
Permanent strain (%)	0.725433	0.725433	0.726044	0.726648	0.725433	0.725799	0.000544
Maximum load (kN)	4.31746	4.327228	4.307692	4.307692	4.307692	4.313553	0.008737
Cyclic load (kN)	4.258852	4.278388	4.249084	4.249084	4.249084	4.256899	0.012736
Contact load (kN)	0.058608	0.04884	0.058608	0.058608	0.058608	0.056654	0.004368
Average resilient def. (mm)	0.302967	0.302967	0.301746	0.300537	0.301734	0.30199	0.001018
Axial 1 resilient def. (mm)	0.294969	0.294969	0.294969	0.292552	0.294969	0.294486	0.001081
Axial 2 resilient def. (mm)	0.310965	0.310965	0.308523	0.308523	0.308498	0.309495	0.001342
Actuator resilient def. (mm)	0.47619	0.483516	0.47619	0.47619	0.47619	0.477656	0.003276
Average permanent def. (mm)	1.450867	1.450867	1.452088	1.453297	1.450867	1.451597	0.001087
Axial 1 permanent def. (mm)	1.461172	1.461172	1.461172	1.46359	1.461172	1.461656	0.001081
Axial 2 permanent def. (mm)	1.440562	1.440562	1.443004	1.443004	1.440562	1.441538	0.001338
Actuator permanent def. (mm)	1.472527	1.472527	1.472527	1.472527	1.472527	1.472527	0
Sequence Number	51						
Cycle Number	496	497	498	499	500	Average	Std Dev.
Resilient Modulus (MPa)	357.890203	360.797752	357.890203	355.650649	357.285825	357.902927	1.859698
Resilient micro-strain	1515.140415	1502.930403	1515.140415	1521.184371	1521.184371	1515.115995	7.452185
Confining pressure (kPa)	50.695971	50.40293	50.40293	50.40293	50.40293	50.461538	0.131052
Maximum axial stress (kPa)	549.716121	549.716121	549.716121	548.472419	549.716121	549.467381	0.5562
Cyclic stress (kPa)	542.253911	542.253911	542.253911	541.010209	543.497613	542.253911	0.87943
Contact stress (kPa)	7.46221	7.46221	7.46221	7.46221	6.218508	7.213469	0.5562
Permanent strain (%)	0.731508	0.731508	0.731508	0.730904	0.730904	0.731266	0.000331
Maximum load (kN)	4.31746	4.31746	4.31746	4.307692	4.31746	4.315507	0.004368
Cyclic load (kN)	4.258852	4.258852	4.258852	4.249084	4.26862	4.258852	0.006907
Contact load (kN)	0.058608	0.058608	0.058608	0.058608	0.04884	0.056654	0.004368
Average resilient def. (mm)	0.303028	0.300586	0.303028	0.304237	0.304237	0.303023	0.00149
Axial 1 resilient def. (mm)	0.294969	0.292552	0.294969	0.297387	0.297387	0.295453	0.002023
Axial 2 resilient def. (mm)	0.311087	0.30862	0.311087	0.311087	0.311087	0.310593	0.001103
Actuator resilient def. (mm)	0.47619	0.47619	0.483516	0.47619	0.47619	0.477656	0.003276
Average permanent def. (mm)	1.463016	1.463016	1.463016	1.461807	1.461807	1.462532	0.000662
Axial 1 permanent def. (mm)	1.47326	1.47326	1.47326	1.470842	1.470842	1.472293	0.001324
Axial 2 permanent def. (mm)	1.452772	1.452772	1.452772	1.452772	1.452772	1.452772	0
Actuator permanent def. (mm)	1.487179	1.487179	1.487179	1.487179	1.487179	1.487179	0
Sequence Number	52						
Cycle Number	496	497	498	499	500	Average	Std Dev.
Resilient Modulus (MPa)	353.573467	357.242813	357.846947	353.573467	355.000762	355.447491	2.012714
Resilient micro-strain	1533.638584	1521.367521	1515.323565	1533.638584	1527.472527	1526.288156	7.967045
Confining pressure (kPa)	50.40293	50.40293	50.10989	50.40293	50.40293	50.344322	0.131052
Maximum axial stress (kPa)	549.716121	549.716121	549.716121	549.716121	549.716121	549.716121	0
Cyclic stress (kPa)	542.253911	543.497613	542.253911	542.253911	542.253911	542.502651	0.5562
Contact stress (kPa)	7.46221	6.218508	7.46221	7.46221	7.46221	7.213469	0.5562
Permanent strain (%)	0.735763	0.736374	0.736978	0.736368	0.735763	0.736249	0.000508
Maximum load (kN)	4.31746	4.31746	4.31746	4.31746	4.31746	4.31746	0
Cyclic load (kN)	4.258852	4.26862	4.258852	4.258852	4.258852	4.260806	0.004368
Contact load (kN)	0.058608	0.04884	0.058608	0.058608	0.058608	0.056654	0.004368
Average resilient def. (mm)	0.306728	0.304274	0.303065	0.306728	0.305495	0.305258	0.001593
Axial 1 resilient def. (mm)	0.299805	0.299805	0.297387	0.299805	0.299805	0.299321	0.001081
Axial 2 resilient def. (mm)	0.313651	0.308742	0.308742	0.313651	0.311184	0.311194	0.002454
Actuator resilient def. (mm)	0.483516	0.483516	0.47619	0.483516	0.483516	0.482051	0.003276
Average permanent def. (mm)	1.471526	1.472747	1.473956	1.472735	1.471526	1.472498	0.001016
Axial 1 permanent def. (mm)	1.480513	1.480513	1.48293	1.48293	1.480513	1.48148	0.001324
Axial 2 permanent def. (mm)	1.46254	1.464982	1.464982	1.46254	1.46254	1.463516	0.001338
Actuator permanent def. (mm)	1.501832	1.501832	1.501832	1.501832	1.501832	1.501832	0
Sequence Number	53						
Cycle Number	496	497	498	499	500	Average	Std Dev.
Resilient Modulus (MPa)	356.96867	358.412426	356.339528	358.59546	355.743892	357.211995	1.258048
Resilient micro-strain	1515.567766	1509.462759	1521.733822	1515.628816	1527.777778	1518.034188	6.963535
Confining pressure (kPa)	50.40293	50.10989	50.40293	50.10989	50.695971	50.344322	0.245175
Maximum axial stress (kPa)	548.472419	548.472419	549.716121	549.716121	550.959823	549.467381	1.040555
Cyclic stress (kPa)	541.010209	541.010209	542.253911	543.497613	543.497613	542.253911	1.243702
Contact stress (kPa)	7.46221	7.46221	7.46221	6.218508	7.46221	7.213469	0.5562
Permanent strain (%)	0.741838	0.742448	0.741838	0.742448	0.741838	0.742082	0.000334
Maximum load (kN)	4.307692	4.307692	4.31746	4.31746	4.327228	4.315507	0.008173
Cyclic load (kN)	4.249084	4.249084	4.258852	4.26862	4.26862	4.258852	0.009768
Contact load (kN)	0.058608	0.058608	0.058608	0.04884	0.058608	0.056654	0.004368
Average resilient def. (mm)	0.303114	0.301893	0.304347	0.303126	0.305556	0.303607	0.001393
Axial 1 resilient def. (mm)	0.294945	0.294945	0.294945	0.294945	0.297363	0.295429	0.001081
Axial 2 resilient def. (mm)	0.311282	0.30884	0.313748	0.311306	0.313748	0.311785	0.002053
Actuator resilient def. (mm)	0.47619	0.47619	0.468864	0.47619	0.483516	0.47619	0.00518

Average permanent def. (mm)	1.483675	1.484896	1.483675	1.484896	1.483675	1.484164	0.000669
Axial 1 permanent def. (mm)	1.495043	1.495043	1.495043	1.495043	1.495043	1.495043	0
Axial 2 permanent def. (mm)	1.472308	1.47475	1.472308	1.47475	1.472308	1.473284	0.001338
Actuator permanent def. (mm)	1.509158	1.509158	1.509158	1.509158	1.509158	1.509158	0
Sequence Number	54						
Cycle Number	496	497	498	499	500	Average	Std Dev.
Resilient Modulus (MPa)	354.115773	352.115721	359.221834	358.412426	356.954291	356.164009	2.983878
Resilient micro-strain	1527.777778	1539.98779	1509.52381	1509.462759	1515.628816	1520.47619	13.217063
Confining pressure (kPa)	50.10989	50.40293	50.40293	50.10989	50.40293	50.285714	0.160505
Maximum axial stress (kPa)	548.472419	549.716121	549.716121	548.472419	548.472419	548.9699	0.681203
Cyclic stress (kPa)	541.010209	542.253911	542.253911	541.010209	541.010209	541.50769	0.681203
Contact stress (kPa)	7.46221	7.46221	7.46221	7.46221	7.46221	7.46221	0
Permanent strain (%)	0.746722	0.746722	0.747943	0.747332	0.747332	0.74721	0.000511
Maximum load (kN)	4.307692	4.31746	4.31746	4.307692	4.307692	4.3116	0.00535
Cyclic load (kN)	4.249084	4.258852	4.258852	4.249084	4.249084	4.252991	0.00535
Contact load (kN)	0.058608	0.058608	0.058608	0.058608	0.058608	0.058608	0
Average resilient def. (mm)	0.305556	0.307998	0.301905	0.301893	0.303126	0.304095	0.002643
Axial 1 resilient def. (mm)	0.297265	0.299683	0.292405	0.294847	0.294847	0.29581	0.002764
Axial 2 resilient def. (mm)	0.313846	0.316313	0.311404	0.308938	0.311404	0.312381	0.0028
Actuator resilient def. (mm)	0.47619	0.483516	0.47619	0.47619	0.47619	0.477656	0.003276
Average permanent def. (mm)	1.493443	1.493443	1.495885	1.494664	1.494664	1.49442	0.001022
Axial 1 permanent def. (mm)	1.504811	1.504811	1.507253	1.504811	1.504811	1.505299	0.001092
Axial 2 permanent def. (mm)	1.482076	1.482076	1.484518	1.484518	1.484518	1.483541	0.001338
Actuator permanent def. (mm)	1.516484	1.516484	1.516484	1.516484	1.516484	1.516484	0
Sequence Number	55						
Cycle Number	496	497	498	499	500	Average	Std Dev.
Resilient Modulus (MPa)	354.313894	354.115773	355.743892	357.803701	354.929833	355.381419	1.495346
Resilient micro-strain	1533.943834	1527.777778	1527.777778	1515.506716	1527.777778	1526.556777	6.729506
Confining pressure (kPa)	50.40293	50.40293	50.695971	50.40293	50.10989	50.40293	0.207211
Maximum axial stress (kPa)	549.716121	548.472419	549.716121	549.716121	549.716121	549.467381	0.5562
Cyclic stress (kPa)	543.497613	541.010209	543.497613	542.253911	542.253911	542.502651	1.040555
Contact stress (kPa)	6.218508	7.46221	6.218508	7.46221	7.46221	6.964729	0.681203
Permanent strain (%)	0.751606	0.751606	0.751606	0.752216	0.751606	0.751728	0.000273
Maximum load (kN)	4.31746	4.307692	4.31746	4.31746	4.31746	4.315507	0.004368
Cyclic load (kN)	4.26862	4.249084	4.26862	4.258852	4.258852	4.260806	0.008173
Contact load (kN)	0.04884	0.058608	0.04884	0.058608	0.058608	0.054701	0.00535
Average resilient def. (mm)	0.306789	0.305556	0.305556	0.303101	0.305556	0.305311	0.001346
Axial 1 resilient def. (mm)	0.297167	0.297167	0.297167	0.297167	0.297167	0.297167	0
Axial 2 resilient def. (mm)	0.31641	0.313944	0.313944	0.309035	0.313944	0.313455	0.002692
Actuator resilient def. (mm)	0.47619	0.483516	0.47619	0.47619	0.47619	0.477656	0.003276
Average permanent def. (mm)	1.503211	1.503211	1.503211	1.504432	1.503211	1.503455	0.000546
Axial 1 permanent def. (mm)	1.514579	1.514579	1.514579	1.514579	1.514579	1.514579	0
Axial 2 permanent def. (mm)	1.491844	1.491844	1.491844	1.494286	1.491844	1.492332	0.001092
Actuator permanent def. (mm)	1.531136	1.52381	1.531136	1.531136	1.531136	1.52967	0.003276
Sequence Number	56						
Cycle Number	496	497	498	499	500	Average	Std Dev.
Resilient Modulus (MPa)	357.171149	350.160907	354.129925	356.368122	352.129681	353.991957	2.911936
Resilient micro-strain	1521.672772	1552.136752	1527.716728	1521.611722	1539.92674	1532.612943	13.222688
Confining pressure (kPa)	50.989011	50.10989	50.695971	50.10989	50.40293	50.461538	0.382078
Maximum axial stress (kPa)	550.959823	550.959823	548.472419	549.716121	549.716121	549.964861	1.040555
Cyclic stress (kPa)	543.497613	543.497613	541.010209	542.253911	542.253911	542.502651	1.040555
Contact stress (kPa)	7.46221	7.46221	7.46221	7.46221	7.46221	7.46221	0
Permanent strain (%)	0.7571	0.755879	0.755879	0.75649	0.755879	0.756245	0.000546
Maximum load (kN)	4.327228	4.327228	4.307692	4.31746	4.31746	4.319414	0.008173
Cyclic load (kN)	4.26862	4.26862	4.249084	4.258852	4.258852	4.260806	0.008173
Contact load (kN)	0.058608	0.058608	0.058608	0.058608	0.058608	0.058608	0
Average resilient def. (mm)	0.304335	0.310427	0.305543	0.304322	0.307985	0.306523	0.002645
Axial 1 resilient def. (mm)	0.29707	0.304347	0.299512	0.29707	0.301929	0.299985	0.003163
Axial 2 resilient def. (mm)	0.3116	0.316508	0.311575	0.311575	0.314042	0.31306	0.002202
Actuator resilient def. (mm)	0.483516	0.490842	0.47619	0.483516	0.483516	0.483516	0.00518
Average permanent def. (mm)	1.5142	1.511758	1.511758	1.512979	1.511758	1.512491	0.001092
Axial 1 permanent def. (mm)	1.524347	1.521905	1.521905	1.524347	1.521905	1.522882	0.001338
Axial 2 permanent def. (mm)	1.504054	1.501612	1.501612	1.501612	1.501612	1.5021	0.001092
Actuator permanent def. (mm)	1.538462	1.538462	1.538462	1.538462	1.538462	1.538462	0
Sequence Number	57						
Cycle Number	496	497	498	499	500	Average	Std Dev.
Resilient Modulus (MPa)	353.54532	355.758108	353.531248	355.758108	355.536499	354.825856	1.178875
Resilient micro-strain	1533.760684	1527.716728	1533.821734	1527.716728	1521.672772	1528.937729	5.071383
Confining pressure (kPa)	50.40293	50.40293	50.10989	50.10989	50.40293	50.285714	0.160505
Maximum axial stress (kPa)	549.716121	549.716121	549.716121	549.716121	548.472419	549.467381	0.5562
Cyclic stress (kPa)	542.253911	543.497613	542.253911	543.497613	541.010209	542.502651	1.040555
Contact stress (kPa)	7.46221	6.218508	7.46221	6.218508	7.46221	6.964729	0.681203
Permanent strain (%)	0.759542	0.760763	0.760153	0.760763	0.760763	0.760397	0.000546
Maximum load (kN)	4.31746	4.31746	4.31746	4.31746	4.307692	4.315507	0.004368

Cyclic load (kN)	4.258852	4.26862	4.258852	4.26862	4.249084	4.260806	0.008173
Contact load (kN)	0.058608	0.04884	0.058608	0.04884	0.058608	0.054701	0.00535
Average resilient def. (mm)	0.306752	0.305543	0.306764	0.305543	0.304335	0.305788	0.001014
Axial 1 resilient def. (mm)	0.301856	0.299414	0.299414	0.299414	0.296996	0.299419	0.001718
Axial 2 resilient def. (mm)	0.311648	0.311673	0.314115	0.311673	0.311673	0.312156	0.001095
Actuator resilient def. (mm)	0.483516	0.47619	0.483516	0.47619	0.468864	0.477656	0.006129
Average permanent def. (mm)	1.519084	1.521526	1.520305	1.521526	1.521526	1.520794	0.001092
Axial 1 permanent def. (mm)	1.529231	1.531673	1.531673	1.531673	1.531673	1.531184	0.001092
Axial 2 permanent def. (mm)	1.508938	1.51138	1.508938	1.51138	1.51138	1.510403	0.001338
Actuator permanent def. (mm)	1.545788	1.553114	1.545788	1.553114	1.553114	1.550183	0.004013
Sequence Number	58						
Cycle Number	496	497	498	499	500	Average	Std Dev.
Resilient Modulus (MPa)	355.56503	352.734436	352.129681	354.944016	354.342099	353.943052	1.461254
Resilient micro-strain	1521.550672	1533.760684	1539.92674	1527.716728	1533.821734	1531.355311	6.976903
Confining pressure (kPa)	50.10989	50.40293	50.40293	50.10989	50.40293	50.285714	0.160505
Maximum axial stress (kPa)	549.716121	549.716121	549.716121	548.472419	549.716121	549.467381	0.5562
Cyclic stress (kPa)	541.010209	541.010209	542.253911	542.253911	543.497613	542.005171	1.040555
Contact stress (kPa)	8.705911	8.705911	7.46221	6.218508	6.218508	7.46221	1.243702
Permanent strain (%)	0.765647	0.764426	0.764426	0.764426	0.765037	0.764792	0.000546
Maximum load (kN)	4.31746	4.31746	4.31746	4.307692	4.31746	4.315507	0.004368
Cyclic load (kN)	4.249084	4.249084	4.258852	4.258852	4.26862	4.256899	0.008173
Contact load (kN)	0.068376	0.068376	0.058608	0.04884	0.04884	0.058608	0.009768
Average resilient def. (mm)	0.30431	0.306752	0.307985	0.305543	0.306764	0.306271	0.001395
Axial 1 resilient def. (mm)	0.299316	0.301758	0.301758	0.299341	0.299316	0.300298	0.001333
Axial 2 resilient def. (mm)	0.309304	0.311746	0.314212	0.311746	0.314212	0.312244	0.002055
Actuator resilient def. (mm)	0.47619	0.483516	0.483516	0.47619	0.483516	0.480586	0.004013
Average permanent def. (mm)	1.531294	1.528852	1.528852	1.528852	1.530073	1.529585	0.001092
Axial 1 permanent def. (mm)	1.541441	1.538999	1.538999	1.538999	1.541441	1.539976	0.001338
Axial 2 permanent def. (mm)	1.521148	1.518706	1.518706	1.518706	1.518706	1.519194	0.001092
Actuator permanent def. (mm)	1.56044	1.56044	1.56044	1.56044	1.56044	1.56044	0
Sequence Number	59						
Cycle Number	496	497	498	499	500	Average	Std Dev.
Resilient Modulus (MPa)	351.54363	355.550764	356.368122	355.152951	352.720396	354.267172	2.040612
Resilient micro-strain	1546.031746	1521.611722	1521.611722	1533.821734	1533.821734	1531.379731	10.215629
Confining pressure (kPa)	50.40293	50.40293	50.40293	50.10989	50.40293	50.344322	0.131052
Maximum axial stress (kPa)	549.716121	548.472419	549.716121	552.203524	548.472419	549.716121	1.523217
Cyclic stress (kPa)	543.497613	541.010209	542.253911	544.741314	541.010209	542.502651	1.621589
Contact stress (kPa)	6.218508	7.46221	7.46221	7.46221	7.46221	7.213469	0.5562
Permanent strain (%)	0.7687	0.769921	0.769921	0.769921	0.7687	0.769432	0.000669
Maximum load (kN)	4.31746	4.307692	4.31746	4.336996	4.307692	4.31746	0.011963
Cyclic load (kN)	4.26862	4.249084	4.258852	4.278388	4.249084	4.260806	0.012736
Contact load (kN)	0.04884	0.058608	0.058608	0.058608	0.058608	0.056654	0.004368
Average resilient def. (mm)	0.309206	0.304322	0.304322	0.306764	0.306764	0.306276	0.002043
Axial 1 resilient def. (mm)	0.301661	0.296801	0.296801	0.299219	0.299243	0.298745	0.002033
Axial 2 resilient def. (mm)	0.316752	0.311844	0.311844	0.31431	0.314286	0.313807	0.002053
Actuator resilient def. (mm)	0.483516	0.47619	0.47619	0.490842	0.483516	0.482051	0.006129
Average permanent def. (mm)	1.537399	1.539841	1.539841	1.539841	1.537399	1.538864	0.001338
Axial 1 permanent def. (mm)	1.548767	1.551209	1.551209	1.551209	1.548767	1.550232	0.001338
Axial 2 permanent def. (mm)	1.526032	1.528474	1.528474	1.528474	1.526032	1.527497	0.001338
Actuator permanent def. (mm)	1.567766	1.567766	1.567766	1.567766	1.567766	1.567766	0

APPENDIX D

TRIAXIAL TEST

Stabilised red sand :confining pressure 50 kPa

IPC Global Universal Testing Machine
UTM_12 V2.00 Stress - Strain Test

Filename	D:\my research\Lab test Data\Triaxial\RSFALKD\UU-test\RSFALKD-triaxial-50kPa.B12
Operator	Mr.Peerapong Jitsangiam
Test type	Compression test
Notes/Comments	RSFALKD
Specimen shape	Cylindrical

Specimen Information
****

Identification	RSFALKD
Core/Sample Number	

Dimensions	Point 1	Point 2	Point 3	Point 4	Point 5	Point 6	Average	Std Dev.
Diameter (mm)	100						100	
Height (mm)	100						100	

Cross-Sectional area	7853.982
Volume	785398.2

Comments/Properties

Setup Parameters
****

Pre-load stress (kPa)	
Pre-load load (kN)	
Pre-load hold time (s)	
Confining pressure (kPa)	50
Confining hold time (s)	5
Dump pressure at end of test	No
Axial gauge length (mm)	100
Radial gauge length (mm)	
Advanced loading control	Disabled
Control Mode	Displacement (actuator)
Loading Rate (mm/s)	1
Termination Timer (sec)	0
% Unload	0
Minimum stress (kPa)	0
Minimum load (kN)	0
Termination Actuator (mm)	0
Termination Axial (mm)	250
Termination Radial (mm)	0

Calibration Information
****

Channel description	Filename	Transducer description	Span	Units	Date	Linearised
A: Axial Force	Y12346.CAR	STC5000 S/N: Y12346 +/- 20kN	40	kN	7/12/2005	No
B: Actuator LVDT	941C-340.CAR	AC-15 S/N: M992941C-340 +/-15mm	30	mm	7/12/2005	No
C: Axial LVDT #1	83047.car	D6-05000A S/N: 83047 +/- 5mm	10	mm	#########	Yes
D: Axial LVDT #2	83048.car	D6-05000A S/N: 83048 +/- 5mm	10	mm	#########	Yes
E: Radial LVDT #1	S054041.CAR	IT2000AG S/N: S054041 +/- 600kPa	1200	kPa	#########	No
F: Radial LVDT #2		Undefined/Not Used	1	?		No
G: Temperature Probe		Undefined/Not Used	1	?		No
H: Confining Pressure	S054041.CAR	IT2000AG S/N: S054041 +/- 600kPa	1200	kPa	#########	No

Test Results
****

Start date and time	Wednesday	December 20	2006	at 12:17 PM
Timer (sec)	21			
Peak compressive stress (kPa)	941.5			
Peak load (kN)	7.394			
Actuator strain at peak load (%)	3.758			
Actuator deformation at peak load (mm)	3.758			
Axial av. strain at peak load (%)	3.444			
Axial av. deform. at peak load (mm)	3.444			

Time	Stress	Actuator Strain	Axial average strain	Load	Actuator	Axial LVDT #1	Axial LVDT #2	Confining Pressure
(sec)	(kPa)	(%)	(%)	(kN)	(mm)	(mm)	(mm)	(kPa)
0	1.244	0	0	0.00977	0	0	0	49.52
0.02	113.177	0.32234	0.2569	0.88889	0.322344	0.234432	0.279365	49.52
0.04	120.639	0.34432	0.27538	0.9475	0.344322	0.253968	0.296801	49.82
0.06	129.345	0.3663	0.29389	1.01587	0.3663	0.271062	0.316728	50.11
0.08	136.807	0.38828	0.31238	1.07448	0.388278	0.290598	0.334164	49.52
0.1	145.513	0.40293	0.32842	1.14286	0.40293	0.30525	0.3516	49.52
0.12	152.975	0.42491	0.34685	1.20147	0.424908	0.322344	0.371355	49.82
0.14	161.681	0.44689	0.36525	1.26984	0.446886	0.34188	0.38862	50.11
0.16	170.387	0.46886	0.38243	1.33822	0.468864	0.358974	0.405885	49.82
0.18	179.093	0.49084	0.39962	1.40659	0.490842	0.373626	0.425617	49.82
0.2	194.017	0.5348	0.43029	1.52381	0.534799	0.405372	0.455214	51.28
0.22	196.505	0.5348	0.43642	1.54335	0.534799	0.412698	0.460147	49.82
0.24	206.454	0.55678	0.45484	1.62149	0.556777	0.429792	0.479878	49.52
0.26	215.16	0.57143	0.47325	1.68987	0.571429	0.446886	0.499609	49.82
0.28	225.11	0.60073	0.49165	1.76801	0.600733	0.466422	0.516874	50.11
0.3	232.572	0.61538	0.50883	1.82662	0.615385	0.483516	0.534139	49.82
0.32	241.278	0.63004	0.52355	1.89499	0.630037	0.498168	0.548938	49.52
0.34	251.228	0.65934	0.54319	1.97314	0.659341	0.517705	0.568669	49.52
0.36	259.934	0.68132	0.56282	2.04151	0.681319	0.537241	0.5884	49.52
0.38	269.883	0.7033	0.58123	2.11966	0.703297	0.554335	0.608132	49.52
0.4	279.833	0.71795	0.59841	2.1978	0.717949	0.571429	0.625397	49.82

0.42	288.539	0.74725	0.61803	2.26618	0.747253	0.593407	0.642662	50.11
0.44	298.488	0.77656	0.63767	2.34432	0.776557	0.612943	0.662393	50.11
0.46	305.951	0.78388	0.65117	2.40293	0.783883	0.625153	0.677192	49.52
0.48	315.9	0.80586	0.67081	2.48107	0.805861	0.644689	0.696923	49.82
0.5	324.606	0.82784	0.69044	2.54945	0.827839	0.664225	0.716654	49.82
0.52	333.312	0.84982	0.70762	2.61783	0.849817	0.681319	0.733919	49.52
0.54	343.262	0.87179	0.72725	2.69597	0.871795	0.700855	0.753651	49.82
0.56	351.968	0.89377	0.74567	2.76435	0.893773	0.717949	0.773382	50.11
0.58	359.43	0.90842	0.76162	2.82295	0.908425	0.732601	0.790647	49.52
0.6	369.379	0.93773	0.78126	2.9011	0.937729	0.752137	0.810379	50.11
0.62	378.085	0.95971	0.80089	2.96947	0.959707	0.771673	0.83011	49.82
0.64	386.791	0.98168	0.81684	3.03785	0.981685	0.788767	0.844908	49.52
0.66	396.741	0.99634	0.8377	3.116	0.996337	0.808303	0.867106	50.11
0.68	405.447	1.02564	0.85734	3.18437	1.025641	0.827839	0.886838	50.11
0.7	412.909	1.03297	0.87206	3.24298	1.032967	0.842491	0.901636	49.52
0.72	422.859	1.0696	0.89537	3.32112	1.069597	0.866911	0.923834	50.11
0.74	436.539	1.11355	0.92238	3.42857	1.113553	0.891331	0.953431	51.28
0.76	439.027	1.10623	0.92973	3.44811	1.106227	0.901099	0.958364	49.82
0.78	447.733	1.12821	0.94814	3.51648	1.128205	0.918193	0.978095	49.52
0.8	455.195	1.15018	0.96778	3.57509	1.150183	0.937729	0.997827	49.52
0.82	463.901	1.17216	0.98745	3.64347	1.172161	0.957338	1.017558	49.52
0.84	472.607	1.19414	1.00595	3.71184	1.194139	0.974603	1.037289	50.11
0.86	478.825	1.20879	1.02198	3.76068	1.208791	0.991868	1.052088	49.52
0.88	490.018	1.24542	1.04788	3.8486	1.245421	1.016532	1.079219	50.11
0.9	496.237	1.26007	1.06144	3.89744	1.260073	1.031331	1.091551	49.52
0.92	503.699	1.27473	1.08117	3.95604	1.274725	1.051062	1.111282	49.82
0.94	512.405	1.30403	1.10214	4.02442	1.304029	1.070794	1.13348	50.11
0.96	519.867	1.31868	1.1194	4.08303	1.318681	1.088059	1.150745	49.52
0.98	527.329	1.34066	1.14037	4.14164	1.340659	1.110256	1.170476	50.11
1	533.548	1.36264	1.15516	4.19048	1.362637	1.125055	1.185275	49.52
1.02	541.01	1.38462	1.17613	4.24908	1.384615	1.144786	1.207473	49.52
1.04	549.716	1.42125	1.19956	4.31746	1.421245	1.169451	1.22967	50.7
1.06	555.935	1.44322	1.21806	4.3663	1.443223	1.186716	1.249402	50.11
1.08	560.909	1.44322	1.23283	4.40537	1.443223	1.201465	1.2642	49.82
1.1	568.372	1.4652	1.24878	4.46398	1.465201	1.218559	1.278999	49.52
1.12	574.59	1.48718	1.26842	4.51282	1.487179	1.235653	1.301197	49.82
1.14	580.809	1.50183	1.28315	4.56166	1.501832	1.250305	1.315995	49.52
1.16	585.783	1.51648	1.30033	4.60073	1.516484	1.267399	1.33326	49.52
1.18	593.246	1.53846	1.31995	4.65934	1.538462	1.289377	1.350525	49.52
1.2	598.22	1.56044	1.33591	4.69841	1.56044	1.304029	1.36779	49.23
1.22	606.926	1.58242	1.35923	4.76679	1.582418	1.326007	1.392454	50.11
1.24	611.901	1.6044	1.37518	4.80586	1.604396	1.343101	1.407253	49.52
1.26	618.12	1.62637	1.39359	4.8547	1.626374	1.360195	1.426984	50.11
1.28	624.338	1.64103	1.41077	4.90354	1.641026	1.377289	1.444249	49.52
1.3	630.557	1.67033	1.43286	4.95238	1.67033	1.399267	1.466447	50.11
1.32	635.532	1.68498	1.44758	4.99145	1.684982	1.413919	1.481245	49.52
1.34	640.506	1.69963	1.46476	5.03053	1.699634	1.431013	1.49851	49.52
1.36	646.725	1.72161	1.48198	5.07937	1.721612	1.448181	1.515775	49.52
1.38	652.943	1.75092	1.50541	5.12821	1.750916	1.472845	1.537973	49.82
1.4	657.918	1.75824	1.52021	5.16728	1.758242	1.485177	1.555238	49.52
1.42	659.162	1.75824	1.53007	5.17705	1.758242	1.495043	1.565104	48.64
1.44	669.111	1.8022	1.55597	5.25519	1.802198	1.522173	1.589768	49.52
1.46	674.086	1.82418	1.57694	5.29426	1.824176	1.544371	1.609499	49.82
1.48	680.305	1.84615	1.5942	5.3431	1.846154	1.55917	1.629231	49.82
1.5	686.523	1.86081	1.61516	5.39194	1.860806	1.581368	1.648962	50.11
1.52	691.498	1.88278	1.63366	5.43101	1.882784	1.598632	1.668694	50.11
1.54	696.473	1.90476	1.65339	5.47009	1.904762	1.618364	1.688425	50.11
1.56	701.448	1.92674	1.66943	5.50916	1.92674	1.635629	1.703223	49.82
1.58	706.423	1.94872	1.69039	5.54823	1.948718	1.65536	1.725421	50.11
1.6	711.397	1.96337	1.70889	5.5873	1.96337	1.675092	1.742686	50.11
1.62	715.128	1.97802	1.72613	5.61661	1.978022	1.692308	1.759951	49.52
1.64	720.103	2.00733	1.74576	5.65568	2.007326	1.711844	1.779683	49.82
1.66	723.834	2.01465	1.75927	5.68498	2.014652	1.724054	1.794481	49.23
1.68	728.809	2.03663	1.7789	5.72405	2.03663	1.74359	1.814212	49.23
1.7	735.028	2.06593	1.79977	5.77289	2.065934	1.763126	1.83641	50.11
1.72	738.759	2.08059	1.81695	5.8022	2.080586	1.78022	1.853675	49.52
1.74	744.977	2.10989	1.8378	5.85104	2.10989	1.802198	1.873407	49.82
1.76	748.708	2.12454	1.85867	5.88034	2.124542	1.821734	1.895604	50.11
1.78	748.708	2.11722	1.86602	5.88034	2.117216	1.831502	1.900537	48.35
1.8	757.414	2.1685	1.89547	5.94872	2.168498	1.860806	1.930134	50.11
1.82	759.902	2.1685	1.90897	5.96825	2.168498	1.873016	1.944933	49.52
1.84	766.12	2.20513	1.93228	6.01709	2.205128	1.897436	1.967131	49.82
1.86	769.851	2.21978	1.94946	6.0464	2.21978	1.91453	1.984396	49.52
1.88	773.582	2.24176	1.96788	6.0757	2.241758	1.931624	2.004127	49.52
1.9	779.801	2.26374	1.98751	6.12454	2.263736	1.95116	2.023858	49.82
1.92	783.532	2.28571	2.00469	6.15385	2.285714	1.968254	2.041123	49.82
1.94	787.263	2.30037	2.02556	6.18315	2.300366	1.98779	2.063321	50.11
1.96	790.994	2.32234	2.04396	6.21245	2.322344	2.007326	2.080586	49.82
1.98	795.969	2.34432	2.06349	6.25153	2.344322	2.026862	2.100122	49.82
2	798.456	2.35897	2.08181	6.27106	2.358974	2.046398	2.117216	49.52
2.02	802.188	2.38095	2.10012	6.30037	2.380952	2.063492	2.136752	49.52
2.04	808.406	2.41026	2.12454	6.34921	2.410256	2.087912	2.161172	50.11
2.06	810.893	2.43223	2.14042	6.36874	2.432234	2.105006	2.175824	50.11
2.08	813.381	2.44689	2.15995	6.38828	2.446886	2.124542	2.19536	50.11
2.1	817.112	2.46154	2.17705	6.41758	2.461538	2.141636	2.212454	49.52
2.12	819.599	2.47619	2.19658	6.43712	2.47619	2.15873	2.234432	49.82
2.14	823.33	2.49817	2.21366	6.46642	2.498168	2.178242	2.249084	49.52
2.16	827.062	2.52015	2.23554	6.49573	2.520147	2.197582	2.273504	49.52
2.18	830.793	2.54212	2.25133	6.52503	2.542125	2.214505	2.288156	49.52
2.2	833.28	2.55678	2.27077	6.54457	2.556777	2.233846	2.307692	49.52
2.22	834.524	2.5641	2.28413	6.55433	2.564103	2.248352	2.319902	48.94
2.24	840.742	2.60073	2.30855	6.60317	2.600733	2.27011	2.346984	49.82
2.26	843.23	2.61538	2.32685	6.62271	2.615385	2.289451	2.364249	49.52
2.28	848.205	2.64469	2.34762	6.66178	2.644689	2.308791	2.386447	50.11
2.3	851.936	2.67399	2.37325	6.69109	2.673993	2.335385	2.411111	50.7
2.32	853.179	2.68132	2.3879	6.70085	2.681319	2.34989	2.42591	49.82
2.34	856.91	2.7033	2.40623	6.73016	2.703297	2.366813	2.445641	49.82
2.36	860.642	2.71795	2.42576	6.75946	2.717949	2.386154	2.465372	49.52
2.38	859.398	2.72527	2.43918	6.74969	2.725275	2.400659	2.477705	48.94
2.4	868.104	2.77656	2.47107	6.81807	2.776557	2.432381	2.509768	50.7
2.42	868.104	2.78388	2.48464	6.81807	2.783883	2.444713	2.524567	49.82
2.44	870.591	2.79853	2.5056	6.83761	2.798535	2.466911	2.544298	49.52
2.46	873.079	2.82051	2.52534	6.85714	2.820513	2.486642	2.564029	49.52
2.48	875.566	2.84249	2.54371	6.87668	2.842491	2.503907	2.583516	49.82
2.5	878.053	2.85714	2.56204	6.89621	2.857143	2.523639	2.60044	49.52
2.52	880.541	2.87912	2.58037	6.91575	2.879121	2.54337	2.617363	49.52
2.54	881.784	2.9011	2.5999	6.92552	2.901099	2.563101	2.636703	49.52

Appendix D: Triaxial test

2.56	884.272	2.92308	2.61821	6.94505	2.923077	2.580366	2.656044	50.11
2.58	886.759	2.93773	2.63774	6.96459	2.937729	2.600098	2.675385	49.52
2.6	889.247	2.95971	2.65486	6.98413	2.959707	2.619829	2.68989	49.52
2.62	891.734	2.98168	2.6756	7.00366	2.981685	2.63956	2.711648	50.11
2.64	895.465	3.00366	2.69514	7.03297	3.003663	2.659292	2.730989	50.11
2.66	896.709	3.01832	2.71446	7.04274	3.018315	2.678584	2.75033	50.11
2.68	899.196	3.03297	2.73129	7.06227	3.032967	2.695336	2.767253	49.52
2.7	900.44	3.04762	2.75054	7.07204	3.047619	2.714481	2.786593	49.52
2.72	905.415	3.08425	2.77339	7.11111	3.084249	2.73602	2.810769	50.11
2.74	905.415	3.0989	2.79289	7.11111	3.098901	2.755165	2.830623	49.52
2.76	916.608	3.17949	2.83316	7.19902	3.179487	2.795849	2.870476	51.87
2.78	909.146	3.14286	2.83316	7.14042	3.142857	2.795849	2.870476	49.52
2.8	907.902	3.15018	2.8515	7.13065	3.150183	2.812601	2.890403	49.23
2.82	912.877	3.18681	2.87592	7.16972	3.186813	2.836532	2.915311	49.52
2.84	917.852	3.23077	2.90154	7.20879	3.230769	2.862857	2.94022	50.7
2.86	914.121	3.22344	2.9138	7.17949	3.223443	2.87243	2.955165	49.52
2.88	915.364	3.24542	2.93209	7.18926	3.245421	2.891575	2.972601	49.82
2.9	917.852	3.26007	2.95053	7.20879	3.260073	2.911013	2.990037	49.82
2.92	917.852	3.28205	2.96921	7.20879	3.282051	2.928449	3.009963	49.82
2.94	919.096	3.2967	2.98913	7.21856	3.296703	2.948376	3.02989	50.11
2.96	919.096	3.31136	3.00283	7.21856	3.311355	2.963321	3.042344	49.52
2.98	922.827	3.33333	3.02521	7.24786	3.333333	2.985739	3.064689	49.52
3	925.314	3.35531	3.04485	7.2674	3.355311	3.005665	3.084029	49.82
3.02	927.801	3.38462	3.06694	7.28694	3.384615	3.028083	3.105788	49.82
3.04	929.045	3.39927	3.08781	7.2967	3.399267	3.050501	3.125128	50.11
3.06	930.289	3.42125	3.10866	7.30647	3.421245	3.070427	3.146886	50.11
3.08	931.533	3.44322	3.13074	7.31624	3.443223	3.092845	3.168645	50.11
3.1	932.776	3.4652	3.15283	7.32601	3.465201	3.115263	3.190403	49.82
3.12	929.045	3.4652	3.16756	7.2967	3.465201	3.130208	3.204908	48.94
3.14	934.02	3.51648	3.19573	7.33578	3.516484	3.159951	3.231502	50.11
3.16	932.776	3.52381	3.21515	7.32601	3.52381	3.177045	3.25326	49.52
3.18	934.02	3.54579	3.23459	7.33578	3.545788	3.196581	3.272601	50.11
3.2	932.776	3.56044	3.25282	7.32601	3.56044	3.216117	3.289524	49.52
3.22	934.02	3.58974	3.27354	7.33578	3.589744	3.235653	3.311429	50.11
3.24	934.02	3.6044	3.29194	7.33578	3.604396	3.255189	3.328694	49.82
3.26	934.02	3.61905	3.30667	7.33578	3.619048	3.269841	3.343492	49.82
3.28	935.264	3.64835	3.3263	7.34554	3.648352	3.289377	3.363223	50.11
3.3	934.02	3.64835	3.34348	7.33578	3.648352	3.306471	3.380488	50.11
3.32	936.507	3.67033	3.35943	7.35531	3.67033	3.323565	3.395287	49.52
3.34	937.751	3.69231	3.38029	7.36508	3.692308	3.343101	3.417485	49.82
3.36	938.995	3.71429	3.40115	7.37485	3.714286	3.365079	3.437216	50.11
3.38	940.238	3.73626	3.42201	7.38462	3.736264	3.384615	3.459414	49.82
3.4	941.482	3.75824	3.4441	7.39438	3.758242	3.406593	3.481612	49.52
3.42	941.482	3.77289	3.46741	7.39438	3.772894	3.431013	3.50381	49.82
3.44	940.238	3.78755	3.48705	7.38462	3.787546	3.450549	3.523541	49.52
3.46	941.482	3.82418	3.51403	7.39438	3.824176	3.474969	3.553089	49.52
3.48	941.482	3.84615	3.53469	7.39438	3.846154	3.496947	3.57243	49.52
3.5	940.238	3.86813	3.55777	7.38462	3.868132	3.518926	3.596606	49.52
3.52	938.995	3.88278	3.57842	7.37485	3.882784	3.540904	3.615946	49.82
3.54	938.995	3.91209	3.59908	7.37485	3.912088	3.562882	3.635287	50.11
3.56	938.995	3.92674	3.6173	7.37485	3.92674	3.579976	3.654628	49.82
3.58	937.751	3.94872	3.63674	7.36508	3.948718	3.599512	3.673968	49.82
3.6	936.507	3.96337	3.65375	7.35531	3.96337	3.616606	3.690891	49.52
3.62	936.507	3.98535	3.67076	7.35531	3.985348	3.6337	3.707814	49.82
3.64	935.264	4	3.68775	7.34554	4	3.648352	3.727155	50.11
3.66	935.264	4.01465	3.70477	7.34554	4.014652	3.667888	3.741661	49.82
3.68	934.02	4.02198	3.72299	7.33578	4.021978	3.684982	3.761001	49.52
3.7	935.264	4.05128	3.74243	7.34554	4.051282	3.704518	3.780342	49.52
3.72	935.264	4.06593	3.75947	7.34554	4.065934	3.724054	3.794896	49.52
3.74	934.02	4.08059	3.77789	7.33578	4.080586	3.741148	3.814628	49.52
3.76	935.264	4.10256	3.7963	7.34554	4.102564	3.758242	3.834359	49.52
3.78	940.238	4.14652	3.82697	7.38462	4.14652	3.789988	3.863956	50.7
3.8	936.507	4.14652	3.8417	7.35531	4.14652	3.80464	3.878755	49.52
3.82	940.238	4.19048	3.86993	7.38462	4.190476	3.831502	3.908352	50.4
3.84	938.995	4.21245	3.89569	7.37485	4.212454	3.858364	3.933016	50.4
3.86	936.507	4.21978	3.9141	7.35531	4.21978	3.875458	3.952747	49.52
3.88	931.533	4.23443	3.93379	7.31624	4.234432	3.895092	3.972479	48.94
3.9	931.533	4.26374	3.95845	7.31624	4.263736	3.919756	3.997143	49.23
3.92	931.533	4.29304	3.98558	7.31624	4.29304	3.949353	4.021807	49.52
3.94	929.045	4.30769	4.0065	7.2967	4.307692	3.969084	4.043907	49.52
3.96	926.558	4.32967	4.02724	7.27717	4.32967	3.988816	4.065665	49.52
3.98	925.314	4.35165	4.04678	7.2674	4.351648	4.008547	4.085006	49.52
4	925.314	4.3663	4.0651	7.2674	4.3663	4.028278	4.101929	49.82
4.02	922.827	4.38095	4.08099	7.24786	4.380952	4.045543	4.116435	49.52
4.04	921.583	4.40293	4.10173	7.2381	4.40293	4.065275	4.138193	49.52
4.06	920.339	4.41758	4.11639	7.22833	4.417582	4.080073	4.152698	50.11
4.08	919.096	4.43956	4.13469	7.21856	4.43956	4.097338	4.172039	49.82
4.1	919.096	4.45421	4.15057	7.21856	4.454212	4.114603	4.186545	50.11
4.12	917.852	4.46886	4.16523	7.20879	4.468864	4.129402	4.20105	49.52
4.14	917.852	4.48352	4.18346	7.20879	4.483516	4.14652	4.220391	49.52
4.16	917.852	4.50549	4.20168	7.20879	4.505495	4.166056	4.237314	49.82
4.18	917.852	4.52015	4.22233	7.20879	4.520147	4.185592	4.259072	49.52
4.2	917.852	4.54212	4.24177	7.20879	4.542125	4.205128	4.278413	49.52
4.22	919.096	4.5641	4.26252	7.21856	4.564103	4.227106	4.297924	49.52
4.24	919.096	4.58608	4.28694	7.21856	4.586081	4.251526	4.322344	49.52
4.26	917.852	4.61538	4.3138	7.20879	4.615385	4.275946	4.351648	50.11
4.28	916.608	4.63736	4.33944	7.19902	4.637363	4.302808	4.376068	49.82
4.3	915.364	4.66667	4.3663	7.18926	4.666667	4.332112	4.400488	50.11
4.32	911.633	4.68864	4.39072	7.15995	4.688645	4.35409	4.42735	50.11
4.34	910.39	4.71795	4.41637	7.15018	4.717949	4.378535	4.454212	50.11
4.36	906.658	4.7326	4.43969	7.12088	4.732601	4.403199	4.47619	49.82
4.38	904.171	4.75458	4.45933	7.10134	4.754579	4.42293	4.495726	49.52
4.4	901.684	4.77656	4.48142	7.08181	4.776557	4.445128	4.517705	50.11
4.42	900.44	4.79121	4.49982	7.07204	4.791209	4.462393	4.537241	49.82
4.44	897.953	4.81319	4.517	7.0525	4.813187	4.479658	4.554335	49.52
4.46	895.465	4.82784	4.53419	7.03297	4.827839	4.499389	4.568987	49.82
4.48	894.221	4.84249	4.55259	7.0232	4.842491	4.516654	4.588523	49.82
4.5	891.734	4.85714	4.56609	7.00366	4.857143	4.531453	4.600733	49.52
4.52	891.734	4.87912	4.58326	7.00366	4.879121	4.546252	4.620269	49.82
4.54	890.49	4.89377	4.59922	6.99389	4.893773	4.563516	4.634921	49.82
4.56	890.49	4.90842	4.61394	6.99389	4.908425	4.578315	4.649573	50.11
4.58	889.247	4.92308	4.6299	6.98413	4.923077	4.59558	4.664225	49.82
4.6	891.734	4.94505	4.6483	7.00366	4.945055	4.612845	4.683761	50.11
4.62	889.247	4.95238	4.66422	6.98413	4.952381	4.630037	4.698413	49.52
4.64	890.49	4.97436	4.6862	6.99389	4.974359	4.649573	4.722833	49.82
4.66	890.49	4.99634	4.70818	6.99389	4.996337	4.673993	4.742369	49.82
4.68	889.247	5.02564	4.7326	6.98413	5.025641	4.698413	4.766789	49.52

4.7	888.003	5.04762	4.75934	6.97436	5.047619	4.725275	4.793407	49.52
4.72	888.003	5.07692	4.78728	6.97436	5.076923	4.752137	4.822418	50.11
4.74	885.516	5.0989	4.814	6.95482	5.098901	4.778999	4.849011	49.52
4.76	881.784	5.12821	4.84316	6.92552	5.128205	4.808303	4.878022	49.82
4.78	878.053	5.15751	4.86868	6.89621	5.157509	4.835165	4.902198	49.82
4.8	875.566	5.17949	4.89298	6.87668	5.179487	4.859585	4.926374	50.11
4.82	870.591	5.19414	4.91371	6.83761	5.194139	4.881709	4.945714	49.52
4.84	869.347	5.22344	4.93567	6.82784	5.223443	4.901441	4.96989	50.11
4.86	866.86	5.24542	4.95523	6.8083	5.245421	4.923639	4.986813	50.11
4.88	863.129	5.25275	4.97109	6.779	5.252747	4.938437	5.003736	49.52
4.9	860.642	5.2674	4.98574	6.75946	5.267399	4.953236	5.018242	49.52
4.92	859.398	5.28205	5.00039	6.74969	5.282051	4.968034	5.032747	49.52
4.94	856.91	5.2967	5.01504	6.73016	5.296703	4.982833	5.047253	49.52
4.96	856.91	5.31136	5.03337	6.73016	5.311355	5.002564	5.064176	50.11
4.98	855.667	5.33333	5.04679	6.72039	5.333333	5.014896	5.078681	50.11
5	854.423	5.34066	5.06023	6.71062	5.340659	5.029695	5.090769	49.82
5.02	854.423	5.35531	5.07365	6.71062	5.355311	5.042027	5.105275	49.82
5.04	854.423	5.36996	5.08954	6.71062	5.369963	5.059292	5.11978	49.52
5.06	854.423	5.38462	5.11031	6.71062	5.384615	5.08149	5.139121	49.82
5.08	854.423	5.40659	5.12861	6.71062	5.406593	5.098755	5.158462	49.52
5.1	855.667	5.4359	5.15414	6.72039	5.435897	5.125641	5.182637	49.82
5.12	855.667	5.45788	5.17952	6.72039	5.457875	5.149817	5.209231	49.82
5.14	851.936	5.48718	5.2037	6.69109	5.487179	5.173993	5.233407	49.23
5.16	851.936	5.51648	5.24238	6.69109	5.516484	5.215092	5.26967	50.11
5.18	848.205	5.54579	5.26897	6.66178	5.545788	5.239267	5.298681	49.82
5.2	843.23	5.56777	5.29678	6.62271	5.567766	5.268278	5.325275	49.52
5.22	840.742	5.59707	5.32821	6.60317	5.59707	5.299707	5.356703	50.11
5.24	835.767	5.62637	5.34875	6.5641	5.626374	5.321465	5.376044	49.82
5.26	832.036	5.64103	5.37172	6.5348	5.641026	5.343223	5.40022	49.82
5.28	829.549	5.67033	5.3936	6.51526	5.67033	5.367643	5.41956	49.82
5.3	827.062	5.68498	5.4119	6.49573	5.684982	5.384908	5.438901	50.11
5.32	823.33	5.69963	5.42902	6.46642	5.699634	5.40464	5.453407	49.82
5.34	820.843	5.72161	5.44488	6.44689	5.721612	5.419438	5.47033	49.82
5.36	818.356	5.72894	5.46198	6.42735	5.728938	5.436703	5.487253	49.82
5.38	817.112	5.74359	5.4754	6.41758	5.74359	5.451502	5.499292	49.52
5.4	813.381	5.75092	5.48631	6.38828	5.750916	5.461368	5.511258	49.52
5.42	813.381	5.77289	5.50212	6.38828	5.772894	5.478632	5.525617	49.82
5.44	812.137	5.78022	5.51427	6.37851	5.78022	5.490965	5.537582	49.52
5.46	810.893	5.79487	5.52762	6.36874	5.794872	5.503297	5.551941	49.52
5.48	809.65	5.8022	5.541	6.35897	5.802198	5.518095	5.563907	49.52
5.5	810.893	5.82418	5.55681	6.36874	5.824176	5.53536	5.578266	49.52
5.52	812.137	5.83883	5.57868	6.37851	5.838828	5.557558	5.599805	49.52
5.54	812.137	5.86081	5.60055	6.37851	5.860806	5.579756	5.621343	49.52
5.56	812.137	5.89011	5.62603	6.37851	5.89011	5.606789	5.645275	50.11
5.58	809.65	5.91941	5.65611	6.35897	5.919414	5.638217	5.673993	49.82
5.6	805.919	5.95604	5.69459	6.32967	5.956044	5.676899	5.712283	50.11
5.62	800.944	5.99267	5.73316	6.2906	5.992674	5.717998	5.748327	50.11
5.64	793.482	6.03663	5.77789	6.23199	6.03663	5.766349	5.789426	50.11
5.66	786.019	6.08059	5.8202	6.17338	6.080586	5.809866	5.830525	49.82
5.68	776.07	6.10989	5.85893	6.09524	6.10989	5.848645	5.869206	49.82
5.7	768.608	6.14652	5.88944	6.03663	6.14652	5.878242	5.900635	49.82
5.72	761.145	6.16117	5.91386	5.97802	6.161172	5.902906	5.924811	49.52
5.74	756.171	6.18315	5.93584	5.93895	6.18315	5.925104	5.946569	49.82
5.76	748.708	6.19048	5.94926	5.88034	6.190476	5.937436	5.961074	49.82
5.78	746.221	6.20513	5.95781	5.86081	6.205128	5.947302	5.968327	49.82
5.8	742.49	6.21978	5.97	5.8315	6.21978	5.959634	5.980366	50.11
5.82	738.759	6.21245	5.97486	5.8022	6.212454	5.964567	5.985153	49.52
5.84	736.271	6.22711	5.98092	5.78266	6.227106	5.969499	5.992332	49.52
5.86	735.028	6.22711	5.98578	5.77289	6.227106	5.974432	5.997118	49.52
5.88	735.028	6.24176	5.9943	5.77289	6.241758	5.984298	6.004298	49.52
5.9	733.784	6.24176	5.99792	5.76313	6.241758	5.986764	6.009084	49.52
5.92	733.784	6.24176	6.00521	5.76313	6.241758	5.994164	6.016264	49.52
5.94	735.028	6.24908	6.01007	5.77289	6.249084	5.999096	6.02105	49.52
5.96	736.271	6.25641	6.01979	5.78266	6.25641	6.008962	6.030623	49.52
5.98	740.002	6.27106	6.03074	5.81197	6.271062	6.021294	6.040195	49.52
6	741.246	6.28571	6.04652	5.82173	6.285714	6.036093	6.056947	49.52
6.02	743.734	6.30769	6.06962	5.84127	6.307692	6.060757	6.078486	50.11
6.04	743.734	6.35165	6.10601	5.84127	6.351648	6.095238	6.116777	50.11
6.06	740.002	6.3956	6.15438	5.81197	6.395604	6.14652	6.162247	49.82
6.08	733.784	6.46154	6.21364	5.76313	6.461538	6.205128	6.222149	50.11
6.1	722.591	6.50549	6.26952	5.67521	6.505495	6.261294	6.277753	49.82
6.12	715.128	6.57143	6.32541	5.61661	6.571429	6.31746	6.333358	50.4
6.14	701.448	6.58608	6.35821	5.50916	6.586081	6.349206	6.367204	49.52
6.16	693.986	6.60806	6.38493	5.45055	6.608059	6.376068	6.393797	50.11
6.18	686.523	6.62271	6.40072	5.39194	6.622711	6.39072	6.41072	50.11
6.2	680.305	6.63736	6.41044	5.3431	6.637363	6.400488	6.420391	49.82
6.22	675.33	6.63736	6.41652	5.30403	6.637363	6.407814	6.425226	49.52
6.24	672.843	6.63736	6.42138	5.28449	6.637363	6.412698	6.430061	49.52
6.26	670.355	6.64469	6.42381	5.26496	6.644689	6.41514	6.432479	49.23
6.28	670.355	6.65201	6.42867	5.26496	6.652015	6.420024	6.437314	49.52
6.3	669.111	6.65201	6.43232	5.25519	6.652015	6.424908	6.439731	49.52
6.32	669.111	6.65934	6.43718	5.25519	6.659341	6.429792	6.444567	49.52
6.34	669.111	6.65934	6.44082	5.25519	6.659341	6.432234	6.449402	49.52
6.36	671.599	6.66667	6.44568	5.27473	6.666667	6.437118	6.454237	49.52
6.38	672.843	6.66667	6.4493	5.28449	6.666667	6.43956	6.459048	49.23
6.4	677.817	6.68864	6.45897	5.32357	6.688645	6.449328	6.46862	49.82
6.42	681.548	6.69597	6.47228	5.35287	6.695971	6.46398	6.480586	50.11
6.44	686.523	6.72527	6.49162	5.39194	6.725275	6.483516	6.499731	50.11
6.46	686.523	6.74725	6.51944	5.39194	6.747253	6.512821	6.526056	50.11
6.48	682.792	6.79853	6.57502	5.36264	6.798535	6.566545	6.583492	50.11
6.5	670.355	6.88645	6.66689	5.26496	6.886447	6.659341	6.674432	50.11
6.52	656.674	6.97436	6.75181	5.15751	6.974359	6.742369	6.761245	50.11
6.54	642.994	7.01099	6.8004	5.05006	7.010989	6.791209	6.809597	50.11
6.56	631.8	7.02564	6.81863	4.96215	7.025641	6.810745	6.82652	49.82
6.58	625.582	7.04029	6.82836	4.91331	7.040293	6.822955	6.833773	49.52
6.6	618.12	7.03297	6.83078	4.8547	7.032967	6.822955	6.838608	50.11
6.62	613.145	7.03297	6.83078	4.81563	7.032967	6.822955	6.838608	49.82
6.64	610.658	7.03297	6.83446	4.79609	7.032967	6.827888	6.841026	50.11
6.66	610.658	7.04029	6.83567	4.79609	7.040293	6.827888	6.843443	49.82
6.68	609.414	7.04762	6.83811	4.78632	7.047619	6.830354	6.845861	49.82
6.7	610.658	7.04762	6.84055	4.79609	7.047619	6.832821	6.848278	50.11
6.72	609.414	7.04762	6.83811	4.78632	7.047619	6.830354	6.845861	49.52
6.74	613.145	7.05495	6.84543	4.81563	7.054945	6.837753	6.853114	50.11
6.76	615.632	7.05495	6.84543	4.83516	7.054945	6.837753	6.853114	49.52
6.78	618.12	7.05495	6.84788	4.8547	7.054945	6.84022	6.855531	49.52
6.8	624.338	7.06227	6.85764	4.90354	7.062271	6.850085	6.865201	49.52
6.82	626.826	7.06227	6.86009	4.92308	7.062271	6.852552	6.867619	48.94

6.84	635.532	7.09158	6.88085	4.99145	7.091575	6.87475	6.88696	49.52
6.86	639.263	7.12088	6.91504	5.02076	7.120879	6.90928	6.920806	49.52
6.88	636.775	7.17949	6.97118	5.00122	7.179487	6.963541	6.978828	49.52
6.9	631.8	7.2381	7.03591	4.96215	7.238095	7.030134	7.041685	49.52
6.92	626.826	7.28938	7.08348	4.92308	7.289377	7.076923	7.090037	49.82
6.94	621.851	7.32601	7.12115	4.884	7.326007	7.115995	7.1263	49.82
6.96	618.12	7.35531	7.14302	4.8547	7.355311	7.137973	7.148059	50.11
6.98	613.145	7.36264	7.16123	4.81563	7.362637	7.155067	7.167399	49.82
7	611.901	7.37729	7.17582	4.80586	7.377289	7.169719	7.181929	50.11
7.02	609.414	7.38462	7.18559	4.78632	7.384615	7.179487	7.191697	49.52
7.04	609.414	7.39927	7.19658	4.78632	7.399267	7.189255	7.203907	50.11
7.06	608.17	7.40659	7.20391	4.77656	7.406593	7.196581	7.211233	50.11
7.08	608.17	7.41392	7.21123	4.77656	7.413919	7.203907	7.218559	50.11
7.1	608.17	7.42125	7.21978	4.77656	7.421245	7.213675	7.225885	50.11
7.12	608.17	7.42857	7.22955	4.77656	7.428571	7.223443	7.235653	50.11
7.14	606.926	7.42125	7.23443	4.76679	7.421245	7.228327	7.240537	48.94
7.16	613.145	7.45788	7.25153	4.81563	7.457875	7.245421	7.257631	49.82
7.18	614.389	7.47253	7.26862	4.8254	7.472527	7.262515	7.274725	49.52
7.2	615.632	7.49451	7.2906	4.83516	7.494505	7.282051	7.299145	49.52
7.22	616.876	7.52381	7.31746	4.84493	7.52381	7.311355	7.323565	49.52
7.24	615.632	7.55311	7.34955	4.83516	7.553114	7.341343	7.357753	49.52
7.26	613.145	7.58242	7.38393	4.81563	7.582418	7.37348	7.394383	49.52
7.28	611.901	7.62637	7.41608	4.80586	7.626374	7.405617	7.426545	49.82
7.3	609.414	7.64835	7.44585	4.78632	7.648352	7.430867	7.46083	49.52
7.32	606.926	7.67033	7.47276	4.76679	7.67033	7.456117	7.489402	49.52
7.34	605.683	7.69963	7.49623	4.75702	7.699634	7.474481	7.517973	49.52
7.36	604.439	7.71429	7.51398	4.74725	7.714286	7.492845	7.535116	49.52
7.38	603.195	7.72894	7.5323	4.73748	7.728938	7.506618	7.557973	49.82
7.4	601.952	7.74359	7.54775	4.72772	7.74359	7.520391	7.575116	50.11
7.42	600.708	7.75824	7.55921	4.71795	7.758242	7.531868	7.586545	49.82
7.44	600.708	7.76557	7.57352	4.71795	7.765568	7.543346	7.603687	49.52
7.46	600.708	7.78022	7.58676	4.71795	7.78022	7.555556	7.617973	49.82
7.48	599.464	7.78022	7.59593	4.70818	7.78022	7.565324	7.626545	49.23
7.5	601.952	7.80952	7.61713	4.72772	7.809524	7.58486	7.649402	50.11
7.52	603.195	7.82418	7.63589	4.73748	7.824176	7.599512	7.672259	50.11
7.54	605.683	7.85348	7.66238	4.75702	7.85348	7.623932	7.70083	50.11
7.56	603.195	7.86081	7.67747	4.73748	7.860806	7.638584	7.716361	49.52
7.58	604.439	7.89744	7.70604	4.74725	7.897436	7.667888	7.7442	50.11
7.6	604.439	7.92674	7.73339	4.74725	7.92674	7.69475	7.772039	49.52
7.62	603.195	7.94872	7.76197	4.73748	7.948718	7.724054	7.799878	49.82
7.64	603.195	7.98535	7.78712	4.73748	7.985348	7.7558	7.818437	50.11
7.66	601.952	8.01465	7.80055	4.72772	8.014652	7.782662	7.818437	50.11
7.68	599.464	8.04396	7.81276	4.70818	8.043956	7.807082	7.818437	50.11
7.7	596.977	8.05861	7.82131	4.68864	8.058608	7.824176	7.818437	49.82
7.72	595.733	8.07326	7.83107	4.67888	8.07326	7.843712	7.818437	49.52
7.74	593.246	8.08791	7.83962	4.65934	8.087912	7.860806	7.818437	49.52
7.76	592.002	8.10989	7.84573	4.64957	8.10989	7.873016	7.818437	49.52
7.78	590.758	8.11722	7.85427	4.6398	8.117216	7.89011	7.818437	49.52
7.8	590.758	8.13187	7.86038	4.6398	8.131868	7.90232	7.818437	49.52
7.82	590.758	8.14652	7.86038	4.6398	8.14652	7.90232	7.818437	49.52
7.84	590.758	8.16117	7.86038	4.6398	8.161172	7.90232	7.818437	49.52
7.86	590.758	8.17582	7.86038	4.6398	8.175824	7.90232	7.818437	49.52
7.88	592.002	8.19048	7.86038	4.64957	8.190476	7.90232	7.818437	49.52
7.9	593.246	8.21245	7.86038	4.65934	8.212454	7.90232	7.818437	49.82
7.92	595.733	8.24176	7.86038	4.67888	8.241758	7.90232	7.818437	50.11
7.94	596.977	8.26374	7.86038	4.68864	8.263736	7.90232	7.818437	50.7
7.96	598.22	8.30037	7.86038	4.69841	8.300366	7.90232	7.818437	50.7
7.98	599.464	8.337	7.86038	4.70818	8.336996	7.90232	7.818437	50.99
8	594.489	8.337	7.86038	4.66911	8.336996	7.90232	7.818437	49.82
8.02	593.246	8.35897	7.86038	4.65934	8.358974	7.90232	7.818437	49.52
8.04	590.758	8.38095	7.86038	4.6398	8.380952	7.90232	7.818437	49.52
8.06	590.758	8.41758	7.86038	4.6398	8.417582	7.90232	7.818437	50.11
8.08	589.515	8.43223	7.86038	4.63004	8.432234	7.90232	7.818437	50.11
8.1	588.271	8.44689	7.86038	4.62027	8.446886	7.90232	7.818437	49.82
8.12	584.54	8.45421	7.86038	4.59096	8.454212	7.90232	7.818437	49.52
8.14	587.027	8.48352	7.86038	4.6105	8.483516	7.90232	7.818437	50.11
8.16	584.54	8.49084	7.86038	4.59096	8.490842	7.90232	7.818437	49.82
8.18	584.54	8.51282	7.86038	4.59096	8.512821	7.90232	7.818437	50.11
8.2	584.54	8.52747	7.86038	4.59096	8.527473	7.90232	7.818437	49.52
8.22	584.54	8.54212	7.86038	4.59096	8.542125	7.90232	7.818437	49.82
8.24	585.783	8.55678	7.86038	4.60073	8.556777	7.90232	7.818437	49.52
8.26	587.027	8.57875	7.86038	4.6105	8.578755	7.90232	7.818437	50.11
8.28	587.027	8.60073	7.86038	4.6105	8.600733	7.90232	7.818437	49.82
8.3	585.783	8.61538	7.86038	4.60073	8.615385	7.90232	7.818437	49.52
8.32	588.271	8.65201	7.86038	4.62027	8.652015	7.90232	7.818437	50.11
8.34	587.027	8.67399	7.86038	4.6105	8.673993	7.90232	7.818437	49.82
8.36	584.54	8.7033	7.86038	4.59096	8.703297	7.90232	7.818437	49.52
8.38	583.296	8.72527	7.86038	4.5812	8.725275	7.90232	7.818437	49.52
8.4	582.052	8.74725	7.86038	4.57143	8.747253	7.90232	7.818437	50.11
8.42	580.809	8.76923	7.86038	4.56166	8.769231	7.90232	7.818437	49.82
8.44	579.565	8.78388	7.86038	4.55189	8.783883	7.90232	7.818437	49.82
8.46	578.321	8.79853	7.86038	4.54212	8.798535	7.90232	7.818437	49.82
8.48	578.321	8.81319	7.86038	4.54212	8.813187	7.90232	7.818437	50.11
8.5	575.834	8.82051	7.86038	4.52259	8.820513	7.90232	7.818437	49.23
8.52	574.59	8.83516	7.86038	4.51282	8.835165	7.90232	7.818437	49.52
8.54	578.321	8.86447	7.86038	4.54212	8.864469	7.90232	7.818437	50.11
8.56	577.078	8.87179	7.86038	4.53236	8.871795	7.90232	7.818437	49.52
8.58	579.565	8.9011	7.86038	4.55189	8.901099	7.90232	7.818437	49.82
8.6	582.052	8.9304	7.86038	4.57143	8.930403	7.90232	7.818437	50.7
8.62	579.565	8.94505	7.86038	4.55189	8.945055	7.90232	7.818437	49.82
8.64	578.321	8.97436	7.86038	4.54212	8.974359	7.90232	7.818437	50.11
8.66	577.078	9.00366	7.86038	4.53236	9.003663	7.90232	7.818437	49.82
8.68	574.59	9.02564	7.86038	4.51282	9.025641	7.90232	7.818437	49.52
8.7	572.103	9.05495	7.86038	4.49328	9.054945	7.90232	7.818437	49.52
8.72	570.859	9.07692	7.86038	4.48352	9.076923	7.90232	7.818437	49.52
8.74	569.615	9.10623	7.86038	4.47375	9.106227	7.90232	7.818437	50.11
8.76	567.128	9.10623	7.86038	4.45421	9.106227	7.90232	7.818437	50.11
8.78	564.641	9.11355	7.86038	4.43468	9.113553	7.90232	7.818437	49.23
8.8	564.641	9.14286	7.86038	4.43468	9.142857	7.90232	7.818437	49.82
8.82	563.397	9.15751	7.86038	4.42491	9.157509	7.90232	7.818437	49.82
8.84	563.397	9.16484	7.86038	4.42491	9.164835	7.90232	7.818437	49.52
8.86	563.397	9.17949	7.86038	4.42491	9.179487	7.90232	7.818437	49.52
8.88	563.397	9.19414	7.86038	4.42491	9.194139	7.90232	7.818437	49.52
8.9	564.641	9.20879	7.86038	4.43468	9.208791	7.90232	7.818437	49.82
8.92	564.641	9.23077	7.86038	4.43468	9.230769	7.90232	7.818437	50.11
8.94	563.397	9.25275	7.86038	4.42491	9.252747	7.90232	7.818437	49.82
8.96	562.153	9.27473	7.86038	4.41514	9.274725	7.90232	7.818437	49.52

8.98	560.909	9.31136	7.86038	4.40537	9.311355	7.90232	7.818437	49.52
9	559.666	9.34799	7.86038	4.3956	9.347985	7.90232	7.818437	50.11
9.02	559.666	9.37729	7.86038	4.3956	9.377289	7.90232	7.818437	50.11
9.04	553.447	9.39927	7.86038	4.34676	9.399267	7.90232	7.818437	49.52
9.06	549.716	9.42125	7.86038	4.31746	9.421245	7.90232	7.818437	49.52
9.08	547.229	9.45055	7.86038	4.29792	9.450549	7.90232	7.818437	49.52
9.1	544.741	9.47253	7.86038	4.27839	9.472527	7.90232	7.818437	49.52
9.12	541.01	9.47985	7.86038	4.24908	9.479853	7.90232	7.818437	49.52
9.14	539.767	9.50183	7.86038	4.23932	9.501832	7.90232	7.818437	49.82
9.16	537.279	9.50916	7.86038	4.21978	9.509158	7.90232	7.818437	49.52
9.18	536.035	9.52381	7.86038	4.21001	9.52381	7.90232	7.818437	49.52
9.2	536.035	9.53114	7.86038	4.21001	9.531136	7.90232	7.818437	49.82
9.22	536.035	9.53846	7.86038	4.21001	9.538462	7.90232	7.818437	49.82
9.24	536.035	9.55311	7.86038	4.21001	9.553114	7.90232	7.818437	49.52
9.26	536.035	9.56777	7.86038	4.21001	9.567766	7.90232	7.818437	50.11
9.28	537.279	9.57509	7.86038	4.21978	9.575092	7.90232	7.818437	49.52
9.3	538.523	9.59707	7.86038	4.22955	9.59707	7.90232	7.818437	49.52
9.32	538.523	9.61172	7.86038	4.22955	9.611722	7.90232	7.818437	49.82
9.34	538.523	9.64103	7.86038	4.22955	9.641026	7.90232	7.818437	50.11
9.36	534.792	9.68498	7.86038	4.20024	9.684982	7.90232	7.818437	49.82
9.38	531.061	9.72161	7.86038	4.17094	9.721612	7.90232	7.818437	49.52
9.4	529.817	9.77289	7.86038	4.16117	9.772894	7.90232	7.818437	50.7
9.42	524.842	9.78755	7.86038	4.1221	9.787546	7.90232	7.818437	49.52
9.44	521.111	9.8022	7.86038	4.0928	9.802198	7.90232	7.818437	49.52
9.46	519.867	9.81685	7.86038	4.08303	9.81685	7.90232	7.818437	49.82
9.48	517.38	9.8315	7.86038	4.06349	9.831502	7.90232	7.818437	49.52
9.5	516.136	9.84615	7.86038	4.05372	9.846154	7.90232	7.818437	49.52
9.52	514.892	9.85348	7.86038	4.04396	9.85348	7.90232	7.818437	50.11
9.54	514.892	9.86813	7.86038	4.04396	9.868132	7.90232	7.818437	49.82
9.56	514.892	9.87546	7.86038	4.04396	9.875458	7.90232	7.818437	49.82
9.58	516.136	9.89744	7.86038	4.05372	9.897436	7.90232	7.818437	50.4
9.6	516.136	9.89744	7.86038	4.05372	9.897436	7.90232	7.818437	49.82
9.62	517.38	9.90476	7.86038	4.06349	9.904762	7.90232	7.818437	49.52
9.64	518.624	9.93407	7.86038	4.07326	9.934066	7.90232	7.818437	50.11
9.66	518.624	9.94872	7.86038	4.07326	9.948718	7.90232	7.818437	49.52
9.68	517.38	9.98535	7.86038	4.06349	9.985348	7.90232	7.818437	49.82
9.7	514.892	10.02198	7.86038	4.04396	10.021978	7.90232	7.818437	49.52
9.72	513.649	10.05128	7.86038	4.03419	10.051282	7.90232	7.818437	49.52
9.74	511.161	10.08059	7.86038	4.01465	10.080586	7.90232	7.818437	49.82
9.76	507.43	10.10989	7.86038	3.98535	10.10989	7.90232	7.818437	49.52
9.78	506.187	10.13187	7.86038	3.97558	10.131868	7.90232	7.818437	49.52
9.8	503.699	10.15385	7.86038	3.95604	10.153846	7.90232	7.818437	50.11
9.82	502.455	10.1685	7.86038	3.94628	10.168498	7.90232	7.818437	49.82
9.84	498.724	10.17582	7.86038	3.91697	10.175824	7.90232	7.818437	49.52
9.86	499.968	10.19048	7.86038	3.92674	10.190476	7.90232	7.818437	49.82
9.88	499.968	10.1978	7.86038	3.92674	10.197802	7.90232	7.818437	50.11
9.9	499.968	10.21245	7.86038	3.92674	10.212454	7.90232	7.818437	50.11
9.92	498.724	10.21245	7.86038	3.91697	10.212454	7.90232	7.818437	49.52
9.94	501.212	10.23443	7.86038	3.93651	10.234432	7.90232	7.818437	50.11
9.96	502.455	10.24908	7.86038	3.94628	10.249084	7.90232	7.818437	50.11
9.98	503.699	10.26374	7.86038	3.95604	10.263736	7.90232	7.818437	49.52
10	503.699	10.28571	7.86038	3.95604	10.285714	7.90232	7.818437	49.82
10.02	503.699	10.32234	7.86038	3.95604	10.322344	7.90232	7.818437	49.52
10.04	499.968	10.3663	7.86038	3.92674	10.3663	7.90232	7.818437	49.52
10.06	497.481	10.40293	7.86038	3.9072	10.40293	7.90232	7.818437	49.52
10.08	493.75	10.43223	7.86038	3.8779	10.432234	7.90232	7.818437	49.52
10.1	491.262	10.45421	7.86038	3.85836	10.454212	7.90232	7.818437	49.82
10.12	490.018	10.47619	7.86038	3.8486	10.47619	7.90232	7.818437	49.82
10.14	488.775	10.49084	7.86038	3.83883	10.490842	7.90232	7.818437	49.52
10.16	488.775	10.50549	7.86038	3.83883	10.505495	7.90232	7.818437	50.11
10.18	487.531	10.50549	7.86038	3.82906	10.505495	7.90232	7.818437	49.52
10.2	487.531	10.52015	7.86038	3.82906	10.520147	7.90232	7.818437	49.52
10.22	487.531	10.52747	7.86038	3.82906	10.527473	7.90232	7.818437	49.52
10.24	487.531	10.5348	7.86038	3.82906	10.534799	7.90232	7.818437	49.52
10.26	488.775	10.54945	7.86038	3.83883	10.549451	7.90232	7.818437	49.23
10.28	490.018	10.57143	7.86038	3.8486	10.571429	7.90232	7.818437	49.52
10.3	491.262	10.59341	7.86038	3.85836	10.593407	7.90232	7.818437	49.52
10.32	491.262	10.62271	7.86038	3.85836	10.622711	7.90232	7.818437	50.11
10.34	491.262	10.65201	7.86038	3.85836	10.652015	7.90232	7.818437	49.82
10.36	490.018	10.68132	7.86038	3.8486	10.681319	7.90232	7.818437	50.11
10.38	487.531	10.71062	7.86038	3.82906	10.710623	7.90232	7.818437	49.82
10.4	485.044	10.7326	7.86038	3.80952	10.732601	7.90232	7.818437	50.11
10.42	485.044	10.7619	7.86038	3.80952	10.761905	7.90232	7.818437	49.82
10.44	483.8	10.77656	7.86038	3.79976	10.776557	7.90232	7.818437	50.11
10.46	481.313	10.79121	7.86038	3.78022	10.791209	7.90232	7.818437	49.82
10.48	482.556	10.81319	7.86038	3.78999	10.813187	7.90232	7.818437	49.82
10.5	481.313	10.82051	7.86038	3.78022	10.820513	7.90232	7.818437	49.52
10.52	481.313	10.83516	7.86038	3.78022	10.835165	7.90232	7.818437	49.82
10.54	481.313	10.84249	7.86038	3.78022	10.842491	7.90232	7.818437	49.52
10.56	480.069	10.84982	7.86038	3.77045	10.849817	7.90232	7.818437	48.94
10.58	483.8	10.87912	7.86038	3.79976	10.879121	7.90232	7.818437	49.82
10.6	483.8	10.89377	7.86038	3.79976	10.893773	7.90232	7.818437	49.52
10.62	485.044	10.92308	7.86038	3.80952	10.923077	7.90232	7.818437	49.52
10.64	483.8	10.95238	7.86038	3.79976	10.952381	7.90232	7.818437	49.52
10.66	482.556	10.98901	7.86038	3.78999	10.989011	7.90232	7.818437	49.52
10.68	481.313	11.01832	7.86038	3.78022	11.018315	7.90232	7.818437	49.52
10.7	478.825	11.04029	7.86038	3.76068	11.040293	7.90232	7.818437	49.52
10.72	478.825	11.06227	7.86038	3.76068	11.062271	7.90232	7.818437	49.82
10.74	477.581	11.07692	7.86038	3.75092	11.076923	7.90232	7.818437	49.82
10.76	476.338	11.09158	7.86038	3.74115	11.091575	7.90232	7.818437	49.82
10.78	477.581	11.11355	7.86038	3.75092	11.113553	7.90232	7.818437	50.11
10.8	476.338	11.12088	7.86038	3.74115	11.120879	7.90232	7.818437	50.11
10.82	477.581	11.12821	7.86038	3.75092	11.128205	7.90232	7.818437	50.11
10.84	477.581	11.14286	7.86038	3.75092	11.142857	7.90232	7.818437	49.52
10.86	477.581	11.16484	7.86038	3.75092	11.164835	7.90232	7.818437	49.52
10.88	478.825	11.18681	7.86038	3.76068	11.186813	7.90232	7.818437	50.11
10.9	477.581	11.20879	7.86038	3.75092	11.208791	7.90232	7.818437	49.82
10.92	477.581	11.23077	7.86038	3.75092	11.230769	7.90232	7.818437	49.52
10.94	478.825	11.25275	7.86038	3.76068	11.252747	7.90232	7.818437	50.11
10.96	478.825	11.28205	7.86038	3.76068	11.282051	7.90232	7.818437	50.11
10.98	477.581	11.2967	7.86038	3.75092	11.296703	7.90232	7.818437	49.82
11	477.581	11.32601	7.86038	3.75092	11.326007	7.90232	7.818437	49.82
11.02	476.338	11.35531	7.86038	3.74115	11.355311	7.90232	7.818437	49.82
11.04	477.581	11.39194	7.86038	3.75092	11.391941	7.90232	7.818437	50.4
11.06	471.363	11.39194	7.86038	3.70208	11.391941	7.90232	7.818437	49.23
11.08	472.607	11.42125	7.86038	3.71184	11.421245	7.90232	7.818437	50.11
11.1	472.607	11.4359	7.86038	3.71184	11.435897	7.90232	7.818437	49.82

11.12	470.119	11.4359	7.86038	3.69231	11.435897	7.90232	7.818437	48.94
11.14	472.607	11.45788	7.86038	3.71184	11.457875	7.90232	7.818437	49.52
11.16	472.607	11.47253	7.86038	3.71184	11.472527	7.90232	7.818437	49.82
11.18	473.85	11.48718	7.86038	3.72161	11.487179	7.90232	7.818437	49.52
11.2	470.119	11.47985	7.86038	3.69231	11.479853	7.90232	7.818437	48.94
11.22	473.85	11.50183	7.86038	3.72161	11.501832	7.90232	7.818437	49.52
11.24	475.094	11.53846	7.86038	3.73138	11.538462	7.90232	7.818437	49.52
11.26	476.338	11.57509	7.86038	3.74115	11.575092	7.90232	7.818437	50.11
11.28	475.094	11.61172	7.86038	3.73138	11.611722	7.90232	7.818437	50.11
11.3	472.607	11.6337	7.86038	3.71184	11.6337	7.90232	7.818437	49.52
11.32	472.607	11.65568	7.86038	3.71184	11.655678	7.90232	7.818437	49.82
11.34	472.607	11.67766	7.86038	3.71184	11.677656	7.90232	7.818437	50.11
11.36	475.094	11.71429	7.86038	3.73138	11.714286	7.90232	7.818437	50.7
11.38	470.119	11.69963	7.86038	3.69231	11.699634	7.90232	7.818437	49.52
11.4	471.363	11.71429	7.86038	3.70208	11.714286	7.90232	7.818437	49.82
11.42	471.363	11.72894	7.86038	3.70208	11.728938	7.90232	7.818437	50.11
11.44	472.607	11.75824	7.86038	3.71184	11.758242	7.90232	7.818437	50.4
11.46	472.607	11.76557	7.86038	3.71184	11.765568	7.90232	7.818437	50.11
11.48	472.607	11.78755	7.86038	3.71184	11.787546	7.90232	7.818437	49.82
11.5	471.363	11.80952	7.86038	3.70208	11.809524	7.90232	7.818437	49.52
11.52	472.607	11.8315	7.86038	3.71184	11.831502	7.90232	7.818437	50.11
11.54	471.363	11.85348	7.86038	3.70208	11.85348	7.90232	7.818437	49.52
11.56	477.581	11.89011	7.86038	3.75092	11.89011	7.90232	7.818437	50.7
11.58	470.119	11.91209	7.86038	3.69231	11.912088	7.90232	7.818437	49.82
11.6	471.363	11.93407	7.86038	3.70208	11.934066	7.90232	7.818437	50.11
11.62	468.876	11.94872	7.86038	3.68254	11.948718	7.90232	7.818437	49.52
11.64	468.876	11.9707	7.86038	3.68254	11.970696	7.90232	7.818437	49.52
11.66	467.632	11.99267	7.86038	3.67277	11.992674	7.90232	7.818437	49.52
11.68	466.388	12.01465	7.86038	3.663	12.014652	7.90232	7.818437	49.52
11.7	465.144	12.0293	7.86038	3.65324	12.029304	7.90232	7.818437	49.82
11.72	465.144	12.04396	7.86038	3.65324	12.043956	7.90232	7.818437	49.82
11.74	466.388	12.05861	7.86038	3.663	12.058608	7.90232	7.818437	50.11
11.76	463.901	12.06593	7.86038	3.64347	12.065934	7.90232	7.818437	50.11
11.78	466.388	12.08059	7.86038	3.663	12.080586	7.90232	7.818437	49.52
11.8	467.632	12.10256	7.86038	3.67277	12.102564	7.90232	7.818437	49.82
11.82	468.876	12.12454	7.86038	3.68254	12.124542	7.90232	7.818437	49.82
11.84	468.876	12.13919	7.86038	3.68254	12.139194	7.90232	7.818437	50.11
11.86	470.119	12.1685	7.86038	3.69231	12.168498	7.90232	7.818437	50.11
11.88	468.876	12.19048	7.86038	3.68254	12.190476	7.90232	7.818437	49.82
11.9	467.632	12.22711	7.86038	3.67277	12.227106	7.90232	7.818437	49.82
11.92	468.876	12.26374	7.86038	3.68254	12.263736	7.90232	7.818437	50.7
11.94	467.632	12.28571	7.86038	3.67277	12.285714	7.90232	7.818437	50.11
11.96	465.144	12.30037	7.86038	3.65324	12.300366	7.90232	7.818437	50.11
11.98	463.901	12.31502	7.86038	3.64347	12.315018	7.90232	7.818437	50.11
12	463.901	12.32234	7.86038	3.64347	12.322344	7.90232	7.818437	49.82
12.02	463.901	12.337	7.86038	3.64347	12.336996	7.90232	7.818437	49.82
12.04	463.901	12.35897	7.86038	3.64347	12.358974	7.90232	7.818437	50.11
12.06	463.901	12.3663	7.86038	3.64347	12.3663	7.90232	7.818437	49.52
12.08	465.144	12.38095	7.86038	3.65324	12.380952	7.90232	7.818437	49.82
12.1	465.144	12.3956	7.86038	3.65324	12.395604	7.90232	7.818437	49.52
12.12	466.388	12.41758	7.86038	3.663	12.417582	7.90232	7.818437	50.11
12.14	465.144	12.44689	7.86038	3.65324	12.446886	7.90232	7.818437	49.52
12.16	465.144	12.47619	7.86038	3.65324	12.47619	7.90232	7.818437	49.52
12.18	465.144	12.50549	7.86038	3.65324	12.505495	7.90232	7.818437	49.52
12.2	463.901	12.52015	7.86038	3.64347	12.520147	7.90232	7.818437	49.52
12.22	463.901	12.54212	7.86038	3.64347	12.542125	7.90232	7.818437	49.52
12.24	463.901	12.5641	7.86038	3.64347	12.564103	7.90232	7.818437	50.11
12.26	463.901	12.58608	7.86038	3.64347	12.586081	7.90232	7.818437	50.11
12.28	462.657	12.58608	7.86038	3.6337	12.586081	7.90232	7.818437	49.52
12.3	463.901	12.61538	7.86038	3.64347	12.615385	7.90232	7.818437	49.82
12.32	463.901	12.63004	7.86038	3.64347	12.630037	7.90232	7.818437	49.82
12.34	463.901	12.64469	7.86038	3.64347	12.644689	7.90232	7.818437	49.52
12.36	465.144	12.65934	7.86038	3.65324	12.659341	7.90232	7.818437	49.52
12.38	467.632	12.7033	7.86038	3.67277	12.703297	7.90232	7.818437	50.7
12.4	465.144	12.71795	7.86038	3.65324	12.717949	7.90232	7.818437	49.82
12.42	465.144	12.73993	7.86038	3.65324	12.739927	7.90232	7.818437	49.82
12.44	462.657	12.7619	7.86038	3.6337	12.761905	7.90232	7.818437	49.52
12.46	462.657	12.79121	7.86038	3.6337	12.791209	7.90232	7.818437	49.82
12.48	462.657	12.80586	7.86038	3.6337	12.805861	7.90232	7.818437	50.11
12.5	462.657	12.82051	7.86038	3.6337	12.820513	7.90232	7.818437	49.52
12.52	461.413	12.84249	7.86038	3.62393	12.842491	7.90232	7.818437	49.82
12.54	458.926	12.84249	7.86038	3.6044	12.842491	7.90232	7.818437	49.52
12.56	465.144	12.89377	7.86038	3.65324	12.893773	7.90232	7.818437	50.99
12.58	461.413	12.89377	7.86038	3.62393	12.893773	7.90232	7.818437	50.11
12.6	462.657	12.9011	7.86038	3.6337	12.901099	7.90232	7.818437	49.52
12.62	462.657	12.92308	7.86038	3.6337	12.923077	7.90232	7.818437	49.52
12.64	461.413	12.94505	7.86038	3.62393	12.945055	7.90232	7.818437	49.52
12.66	461.413	12.97436	7.86038	3.62393	12.974359	7.90232	7.818437	49.52
12.68	462.657	12.99634	7.86038	3.6337	12.996337	7.90232	7.818437	50.11
12.7	461.413	13.01832	7.86038	3.62393	13.018315	7.90232	7.818437	49.82
12.72	461.413	13.04762	7.86038	3.62393	13.047619	7.90232	7.818437	50.11
12.74	460.17	13.06227	7.86038	3.61416	13.062271	7.90232	7.818437	49.23
12.76	460.17	13.08425	7.86038	3.61416	13.084249	7.90232	7.818437	49.82
12.78	460.17	13.0989	7.86038	3.61416	13.098901	7.90232	7.818437	49.82
12.8	458.926	13.11355	7.86038	3.6044	13.113553	7.90232	7.818437	49.82
12.82	458.926	13.12821	7.86038	3.6044	13.128205	7.90232	7.818437	49.82
12.84	458.926	13.15018	7.86038	3.6044	13.150183	7.90232	7.818437	50.11
12.86	460.17	13.17216	7.86038	3.61416	13.172161	7.90232	7.818437	50.11
12.88	458.926	13.18681	7.86038	3.6044	13.186813	7.90232	7.818437	49.82
12.9	455.195	13.18681	7.86038	3.57509	13.186813	7.90232	7.818437	48.94
12.92	458.926	13.23077	7.86038	3.6044	13.230769	7.90232	7.818437	49.82
12.94	460.17	13.25275	7.86038	3.61416	13.252747	7.90232	7.818437	50.11
12.96	458.926	13.27473	7.86038	3.6044	13.274725	7.90232	7.818437	49.82
12.98	458.926	13.2967	7.86038	3.6044	13.296703	7.90232	7.818437	49.52
13	458.926	13.31868	7.86038	3.6044	13.318681	7.90232	7.818437	49.52
13.02	457.682	13.34066	7.86038	3.59463	13.340659	7.90232	7.818437	49.82
13.04	457.682	13.35531	7.86038	3.59463	13.355311	7.90232	7.818437	50.11
13.06	457.682	13.36996	7.86038	3.59463	13.369963	7.90232	7.818437	49.52
13.08	457.682	13.37729	7.86038	3.59463	13.377289	7.90232	7.818437	49.52
13.1	456.438	13.39927	7.86038	3.58486	13.399267	7.90232	7.818437	49.52
13.12	456.438	13.42857	7.86038	3.58486	13.428571	7.90232	7.818437	49.82
13.14	457.682	13.45055	7.86038	3.59463	13.450549	7.90232	7.818437	49.52
13.16	456.438	13.4652	7.86038	3.58486	13.465201	7.90232	7.818437	49.23
13.18	456.438	13.49451	7.86038	3.58486	13.494505	7.90232	7.818437	49.52
13.2	458.926	13.51648	7.86038	3.6044	13.516484	7.90232	7.818437	49.82
13.22	457.682	13.53114	7.86038	3.59463	13.531136	7.90232	7.818437	50.11
13.24	457.682	13.55311	7.86038	3.59463	13.553114	7.90232	7.818437	49.82

13.26	457.682	13.57509	7.86038	3.59463	13.575092	7.90232	7.818437	50.11
13.28	456.438	13.58242	7.86038	3.58486	13.582418	7.90232	7.818437	49.52
13.3	457.682	13.59707	7.86038	3.59463	13.59707	7.90232	7.818437	49.82
13.32	457.682	13.61905	7.86038	3.59463	13.619048	7.90232	7.818437	49.82
13.34	458.926	13.64103	7.86038	3.6044	13.641026	7.90232	7.818437	49.52
13.36	457.682	13.65568	7.86038	3.59463	13.655678	7.90232	7.818437	49.82
13.38	458.926	13.69231	7.86038	3.6044	13.692308	7.90232	7.818437	49.82
13.4	457.682	13.71429	7.86038	3.59463	13.714286	7.90232	7.818437	49.82
13.42	457.682	13.74359	7.86038	3.59463	13.74359	7.90232	7.818437	49.82
13.44	455.195	13.75092	7.86038	3.57509	13.750916	7.90232	7.818437	49.52
13.46	458.926	13.78755	7.86038	3.6044	13.787546	7.90232	7.818437	50.4
13.48	455.195	13.78755	7.86038	3.57509	13.787546	7.90232	7.818437	49.52
13.5	456.438	13.8022	7.86038	3.58486	13.802198	7.90232	7.818437	49.82
13.52	456.438	13.81685	7.86038	3.58486	13.81685	7.90232	7.818437	49.82
13.54	456.438	13.8315	7.86038	3.58486	13.831502	7.90232	7.818437	49.52
13.56	452.707	13.8315	7.86038	3.55556	13.831502	7.90232	7.818437	48.94
13.58	458.926	13.87546	7.86038	3.6044	13.875458	7.90232	7.818437	50.11
13.6	458.926	13.90476	7.86038	3.6044	13.904762	7.90232	7.818437	49.82
13.62	457.682	13.92674	7.86038	3.59463	13.92674	7.90232	7.818437	49.52
13.64	458.926	13.95604	7.86038	3.6044	13.956044	7.90232	7.818437	49.82
13.66	457.682	13.98535	7.86038	3.59463	13.985348	7.90232	7.818437	49.82
13.68	455.195	14.00733	7.86038	3.57509	14.007326	7.90232	7.818437	50.11
13.7	456.438	14.02198	7.86038	3.58486	14.021978	7.90232	7.818437	50.11
13.72	458.926	14.05128	7.86038	3.6044	14.051282	7.90232	7.818437	50.7
13.74	455.195	14.05128	7.86038	3.57509	14.051282	7.90232	7.818437	49.82
13.76	453.951	14.06593	7.86038	3.56532	14.065934	7.90232	7.818437	49.52
13.78	455.195	14.08059	7.86038	3.57509	14.080586	7.90232	7.818437	49.82
13.8	455.195	14.09524	7.86038	3.57509	14.095238	7.90232	7.818437	50.11
13.82	456.438	14.10989	7.86038	3.58486	14.10989	7.90232	7.818437	50.11
13.84	457.682	14.12454	7.86038	3.59463	14.124542	7.90232	7.818437	49.82
13.86	458.926	14.14652	7.86038	3.6044	14.14652	7.90232	7.818437	50.11
13.88	458.926	14.1685	7.86038	3.6044	14.168498	7.90232	7.818437	50.11
13.9	458.926	14.20513	7.86038	3.6044	14.205128	7.90232	7.818437	50.11
13.92	458.926	14.23443	7.86038	3.6044	14.234432	7.90232	7.818437	50.11
13.94	456.438	14.24908	7.86038	3.58486	14.249084	7.90232	7.818437	49.52
13.96	457.682	14.28571	7.86038	3.59463	14.285714	7.90232	7.818437	50.11
13.98	456.438	14.30037	7.86038	3.58486	14.300366	7.90232	7.818437	49.82
14	455.195	14.31502	7.86038	3.57509	14.315018	7.90232	7.818437	49.52
14.02	455.195	14.32234	7.86038	3.57509	14.322344	7.90232	7.818437	49.52
14.04	455.195	14.34432	7.86038	3.57509	14.344322	7.90232	7.818437	49.82
14.06	455.195	14.35897	7.86038	3.57509	14.358974	7.90232	7.818437	49.52
14.08	455.195	14.37363	7.86038	3.57509	14.373626	7.90232	7.818437	49.52
14.1	455.195	14.38828	7.86038	3.57509	14.388278	7.90232	7.818437	49.82
14.12	456.438	14.41026	7.86038	3.58486	14.410256	7.90232	7.818437	50.11
14.14	456.438	14.43223	7.86038	3.58486	14.432234	7.90232	7.818437	49.82
14.16	456.438	14.45421	7.86038	3.58486	14.454212	7.90232	7.818437	49.52
14.18	456.438	14.48352	7.86038	3.58486	14.483516	7.90232	7.818437	49.82
14.2	456.438	14.51282	7.86038	3.58486	14.512821	7.90232	7.818437	49.82
14.22	456.438	14.52747	7.86038	3.58486	14.527473	7.90232	7.818437	49.82
14.24	455.195	14.54945	7.86038	3.57509	14.549451	7.90232	7.818437	49.82
14.26	455.195	14.5641	7.86038	3.57509	14.564103	7.90232	7.818437	49.82
14.28	455.195	14.58608	7.86038	3.57509	14.586081	7.90232	7.818437	50.11
14.3	455.195	14.60073	7.86038	3.57509	14.600733	7.90232	7.818437	49.52
14.32	455.195	14.61538	7.86038	3.57509	14.615385	7.90232	7.818437	49.82
14.34	456.438	14.63004	7.86038	3.58486	14.630037	7.90232	7.818437	49.82
14.36	458.926	14.66667	7.86038	3.6044	14.666667	7.90232	7.818437	50.4
14.38	457.682	14.68864	7.86038	3.59463	14.688645	7.90232	7.818437	50.11
14.4	455.195	14.7033	7.86038	3.57509	14.703297	7.90232	7.818437	50.11
14.42	455.195	14.7326	7.86038	3.57509	14.732601	7.90232	7.818437	50.11
14.44	453.951	14.75458	7.86038	3.56532	14.754579	7.90232	7.818437	49.82
14.46	450.22	14.75458	7.86038	3.53602	14.754579	7.90232	7.818437	48.94
14.48	453.951	14.78388	7.86038	3.56532	14.783883	7.90232	7.818437	49.52
14.5	455.195	14.81319	7.86038	3.57509	14.813187	7.90232	7.818437	50.4
14.52	452.707	14.81319	7.86038	3.55556	14.813187	7.90232	7.818437	49.52
14.54	452.707	14.82784	7.86038	3.55556	14.827839	7.90232	7.818437	49.82
14.56	455.195	14.84982	7.86038	3.57509	14.849817	7.90232	7.818437	50.11
14.58	455.195	14.86447	7.86038	3.57509	14.864469	7.90232	7.818437	49.82
14.6	456.438	14.88645	7.86038	3.58486	14.886447	7.90232	7.818437	49.82
14.62	456.438	14.90842	7.86038	3.58486	14.908425	7.90232	7.818437	49.52
14.64	456.438	14.93773	7.86038	3.58486	14.937729	7.90232	7.818437	49.82
14.66	456.438	14.96703	7.86038	3.58486	14.967033	7.90232	7.818437	50.11
14.68	455.195	14.98901	7.86038	3.57509	14.989011	7.90232	7.818437	49.52
14.7	455.195	15.01832	7.86038	3.57509	15.018315	7.90232	7.818437	50.11
14.72	453.951	15.03297	7.86038	3.56532	15.032967	7.90232	7.818437	49.82
14.74	452.707	15.04762	7.86038	3.55556	15.047619	7.90232	7.818437	49.82
14.76	452.707	15.06227	7.86038	3.55556	15.062271	7.90232	7.818437	49.52
14.78	452.707	15.07692	7.86038	3.55556	15.076923	7.90232	7.818437	49.82
14.8	453.951	15.0989	7.86038	3.56532	15.098901	7.90232	7.818437	50.11
14.82	450.22	15.0989	7.86038	3.53602	15.098901	7.90232	7.818437	49.23
14.84	452.707	15.13553	7.86038	3.55556	15.135531	7.90232	7.818437	49.82
14.86	452.707	15.15751	7.86038	3.55556	15.157509	7.90232	7.818437	49.52
14.88	452.707	15.17216	7.86038	3.55556	15.172161	7.90232	7.818437	49.82
14.9	452.707	15.19414	7.86038	3.55556	15.194139	7.90232	7.818437	49.82
14.92	452.707	15.21612	7.86038	3.55556	15.216117	7.90232	7.818437	49.52
14.94	452.707	15.2381	7.86038	3.55556	15.238095	7.90232	7.818437	49.82
14.96	447.733	15.2381	7.86038	3.51648	15.238095	7.90232	7.818437	48.35
14.98	451.464	15.28938	7.86038	3.54579	15.289377	7.90232	7.818437	49.82
15	450.22	15.31136	7.86038	3.53602	15.311355	7.90232	7.818437	49.82
15.02	450.22	15.33333	7.86038	3.53602	15.333333	7.90232	7.818437	50.11
15.04	448.976	15.34799	7.86038	3.52625	15.347985	7.90232	7.818437	50.11
15.06	448.976	15.36264	7.86038	3.52625	15.362637	7.90232	7.818437	49.82
15.08	448.976	15.37729	7.86038	3.52625	15.377289	7.90232	7.818437	49.82
15.1	448.976	15.39194	7.86038	3.52625	15.391941	7.90232	7.818437	49.82
15.12	447.733	15.39194	7.86038	3.51648	15.391941	7.90232	7.818437	49.52
15.14	450.22	15.41392	7.86038	3.53602	15.413919	7.90232	7.818437	49.52
15.16	451.464	15.4359	7.86038	3.54579	15.435897	7.90232	7.818437	49.52
15.18	452.707	15.4652	7.86038	3.55556	15.465201	7.90232	7.818437	50.11
15.2	451.464	15.48718	7.86038	3.54579	15.487179	7.90232	7.818437	49.52
15.22	451.464	15.51648	7.86038	3.54579	15.516484	7.90232	7.818437	49.82
15.24	452.707	15.55311	7.86038	3.55556	15.553114	7.90232	7.818437	50.4
15.26	447.733	15.55311	7.86038	3.51648	15.553114	7.90232	7.818437	49.23
15.28	448.976	15.58974	7.86038	3.52625	15.589744	7.90232	7.818437	50.11
15.3	447.733	15.6044	7.86038	3.51648	15.604396	7.90232	7.818437	49.82
15.32	447.733	15.62637	7.86038	3.51648	15.626374	7.90232	7.818437	49.82
15.34	447.733	15.64103	7.86038	3.51648	15.641026	7.90232	7.818437	49.82
15.36	447.733	15.663	7.86038	3.51648	15.663004	7.90232	7.818437	49.82
15.38	447.733	15.67033	7.86038	3.51648	15.67033	7.90232	7.818437	49.82

15.4	447.733	15.68498	7.86038	3.51648	15.684982	7.90232	7.818437	49.52
15.42	450.22	15.70696	7.86038	3.53602	15.70696	7.90232	7.818437	50.4
15.44	448.976	15.71429	7.86038	3.52625	15.714286	7.90232	7.818437	49.82
15.46	450.22	15.73626	7.86038	3.53602	15.736264	7.90232	7.818437	49.82
15.48	450.22	15.75824	7.86038	3.53602	15.758242	7.90232	7.818437	49.52
15.5	450.22	15.78755	7.86038	3.53602	15.787546	7.90232	7.818437	49.52
15.52	448.976	15.80952	7.86038	3.52625	15.809524	7.90232	7.818437	49.52
15.54	450.22	15.83883	7.86038	3.53602	15.838828	7.90232	7.818437	49.52
15.56	446.489	15.85348	7.86038	3.50672	15.85348	7.90232	7.818437	49.23
15.58	447.733	15.88278	7.86038	3.51648	15.882784	7.90232	7.818437	49.52
15.6	447.733	15.91209	7.86038	3.51648	15.912088	7.90232	7.818437	50.11
15.62	446.489	15.91941	7.86038	3.50672	15.919414	7.90232	7.818437	49.82
15.64	446.489	15.94139	7.86038	3.50672	15.941392	7.90232	7.818437	49.82
15.66	445.245	15.94872	7.86038	3.49695	15.948718	7.90232	7.818437	49.52
15.68	446.489	15.96337	7.86038	3.50672	15.96337	7.90232	7.818437	49.82
15.7	447.733	15.98535	7.86038	3.51648	15.985348	7.90232	7.818437	49.52
15.72	447.733	16	7.86038	3.51648	16	7.90232	7.818437	50.11
15.74	448.976	16.01465	7.86038	3.52625	16.014652	7.90232	7.818437	50.11
15.76	448.976	16.0293	7.86038	3.52625	16.029304	7.90232	7.818437	49.82
15.78	450.22	16.06593	7.86038	3.53602	16.065934	7.90232	7.818437	50.11
15.8	448.976	16.09524	7.86038	3.52625	16.095238	7.90232	7.818437	50.11
15.82	448.976	16.11722	7.86038	3.52625	16.117216	7.90232	7.818437	49.52
15.84	447.733	16.14652	7.86038	3.51648	16.14652	7.90232	7.818437	49.52
15.86	445.245	16.15385	7.86038	3.49695	16.153846	7.90232	7.818437	49.52
15.88	437.783	16.13919	7.86038	3.43834	16.139194	7.90232	7.818437	47.77
15.9	446.489	16.1978	7.86038	3.50672	16.197802	7.90232	7.818437	50.11
15.92	444.001	16.21245	7.86038	3.48718	16.212454	7.90232	7.818437	49.52
15.94	445.245	16.23443	7.86038	3.49695	16.234432	7.90232	7.818437	49.82
15.96	445.245	16.24908	7.86038	3.49695	16.249084	7.90232	7.818437	50.11
15.98	446.489	16.25641	7.86038	3.50672	16.25641	7.90232	7.818437	49.82
16	446.489	16.27106	7.86038	3.50672	16.271062	7.90232	7.818437	49.52
16.02	445.245	16.27106	7.86038	3.49695	16.271062	7.90232	7.818437	48.64
16.04	448.976	16.30769	7.86038	3.52625	16.307692	7.90232	7.818437	49.52
16.06	448.976	16.337	7.86038	3.52625	16.336996	7.90232	7.818437	49.52
16.08	448.976	16.3663	7.86038	3.52625	16.3663	7.90232	7.818437	49.52
16.1	448.976	16.38828	7.86038	3.52625	16.388278	7.90232	7.818437	49.52
16.12	448.976	16.41026	7.86038	3.52625	16.410256	7.90232	7.818437	49.52
16.14	445.245	16.42491	7.86038	3.49695	16.424908	7.90232	7.818437	49.23
16.16	445.245	16.44689	7.86038	3.49695	16.446886	7.90232	7.818437	49.23
16.18	447.733	16.48352	7.86038	3.51648	16.483516	7.90232	7.818437	49.82
16.2	447.733	16.49817	7.86038	3.51648	16.498168	7.90232	7.818437	49.82
16.22	446.489	16.51282	7.86038	3.50672	16.512821	7.90232	7.818437	49.82
16.24	446.489	16.52747	7.86038	3.50672	16.527473	7.90232	7.818437	49.82
16.26	447.733	16.54212	7.86038	3.51648	16.542125	7.90232	7.818437	50.11
16.28	447.733	16.54945	7.86038	3.51648	16.549451	7.90232	7.818437	49.82
16.3	447.733	16.57143	7.86038	3.51648	16.571429	7.90232	7.818437	49.52
16.32	448.976	16.60073	7.86038	3.52625	16.600733	7.90232	7.818437	50.11
16.34	450.22	16.62271	7.86038	3.53602	16.622711	7.90232	7.818437	50.11
16.36	450.22	16.64469	7.86038	3.53602	16.644689	7.90232	7.818437	49.82
16.38	450.22	16.67399	7.86038	3.53602	16.673993	7.90232	7.818437	49.82
16.4	448.976	16.69597	7.86038	3.52625	16.695971	7.90232	7.818437	49.52
16.42	451.464	16.7326	7.86038	3.54579	16.732601	7.90232	7.818437	50.4
16.44	447.733	16.73993	7.86038	3.51648	16.739927	7.90232	7.818437	49.82
16.46	446.489	16.75458	7.86038	3.50672	16.754579	7.90232	7.818437	49.52
16.48	447.733	16.77656	7.86038	3.51648	16.776557	7.90232	7.818437	50.11
16.5	446.489	16.79121	7.86038	3.50672	16.791209	7.90232	7.818437	49.82
16.52	447.733	16.80586	7.86038	3.51648	16.805861	7.90232	7.818437	49.82
16.54	452.707	16.84982	7.86038	3.55556	16.849817	7.90232	7.818437	51.28
16.56	448.976	16.84249	7.86038	3.52625	16.842491	7.90232	7.818437	50.11
16.58	447.733	16.85714	7.86038	3.51648	16.857143	7.90232	7.818437	49.52
16.6	450.22	16.87912	7.86038	3.53602	16.879121	7.90232	7.818437	50.11
16.62	448.976	16.89377	7.86038	3.52625	16.893773	7.90232	7.818437	49.52
16.64	448.976	16.92308	7.86038	3.52625	16.923077	7.90232	7.818437	49.52
16.66	447.733	16.95238	7.86038	3.51648	16.952381	7.90232	7.818437	49.52
16.68	450.22	16.99634	7.86038	3.53602	16.996337	7.90232	7.818437	50.11
16.7	447.733	17.00366	7.86038	3.51648	17.003663	7.90232	7.818437	49.82
16.72	444.001	17.01099	7.86038	3.48718	17.010989	7.90232	7.818437	48.94
16.74	446.489	17.04029	7.86038	3.50672	17.040293	7.90232	7.818437	49.82
16.76	445.245	17.05495	7.86038	3.49695	17.054945	7.90232	7.818437	49.52
16.78	445.245	17.0696	7.86038	3.49695	17.069597	7.90232	7.818437	50.11
16.8	445.245	17.07692	7.86038	3.49695	17.076923	7.90232	7.818437	49.52
16.82	445.245	17.0989	7.86038	3.49695	17.098901	7.90232	7.818437	49.82
16.84	446.489	17.11355	7.86038	3.50672	17.113553	7.90232	7.818437	49.82
16.86	447.733	17.13553	7.86038	3.51648	17.135531	7.90232	7.818437	49.82
16.88	448.976	17.15751	7.86038	3.52625	17.157509	7.90232	7.818437	49.52
16.9	450.22	17.18681	7.86038	3.53602	17.186813	7.90232	7.818437	50.11
16.92	448.976	17.20147	7.86038	3.52625	17.201465	7.90232	7.818437	49.52
16.94	448.976	17.23077	7.86038	3.52625	17.230769	7.90232	7.818437	49.82
16.96	447.733	17.26007	7.86038	3.51648	17.260073	7.90232	7.818437	49.52
16.98	447.733	17.27473	7.86038	3.51648	17.274725	7.90232	7.818437	49.52
17	447.733	17.30403	7.86038	3.51648	17.304029	7.90232	7.818437	50.11
17.02	444.001	17.31136	7.86038	3.48718	17.311355	7.90232	7.818437	49.23
17.04	445.245	17.33333	7.86038	3.49695	17.333333	7.90232	7.818437	49.52
17.06	446.489	17.34799	7.86038	3.50672	17.347985	7.90232	7.818437	49.52
17.08	445.245	17.36264	7.86038	3.49695	17.362637	7.90232	7.818437	50.11
17.1	447.733	17.37729	7.86038	3.51648	17.377289	7.90232	7.818437	50.4
17.12	447.733	17.39927	7.86038	3.51648	17.399267	7.90232	7.818437	49.82
17.14	448.976	17.41392	7.86038	3.52625	17.413919	7.90232	7.818437	50.11
17.16	448.976	17.42857	7.86038	3.52625	17.428571	7.90232	7.818437	50.11
17.18	450.22	17.45788	7.86038	3.53602	17.457875	7.90232	7.818437	49.82
17.2	450.22	17.47985	7.86038	3.53602	17.479853	7.90232	7.818437	49.52
17.22	450.22	17.50916	7.86038	3.53602	17.509158	7.90232	7.818437	49.82
17.24	450.22	17.53846	7.86038	3.53602	17.538462	7.90232	7.818437	50.11
17.26	450.22	17.56044	7.86038	3.53602	17.56044	7.90232	7.818437	50.11
17.28	447.733	17.56777	7.86038	3.51648	17.567766	7.90232	7.818437	49.52
17.3	447.733	17.59707	7.86038	3.51648	17.59707	7.90232	7.818437	50.11
17.32	447.733	17.61172	7.86038	3.51648	17.611722	7.90232	7.818437	49.52
17.34	447.733	17.62637	7.86038	3.51648	17.626374	7.90232	7.818437	49.52
17.36	447.733	17.64103	7.86038	3.51648	17.641026	7.90232	7.818437	49.52
17.38	447.733	17.663	7.86038	3.51648	17.663004	7.90232	7.818437	50.11
17.4	447.733	17.67033	7.86038	3.51648	17.67033	7.90232	7.818437	49.52
17.42	448.976	17.68498	7.86038	3.52625	17.684982	7.90232	7.818437	49.82
17.44	450.22	17.70696	7.86038	3.53602	17.70696	7.90232	7.818437	49.82
17.46	448.976	17.72894	7.86038	3.52625	17.728938	7.90232	7.818437	49.52
17.48	450.22	17.75092	7.86038	3.53602	17.750916	7.90232	7.818437	49.23
17.5	451.464	17.78755	7.86038	3.54579	17.787546	7.90232	7.818437	50.11
17.52	450.22	17.80952	7.86038	3.53602	17.809524	7.90232	7.818437	49.82

17.54	450.22	17.8315	7.86038	3.53602	17.831502	7.90232	7.818437	49.82
17.56	455.195	17.89011	7.86038	3.57509	17.89011	7.90232	7.818437	51.28
17.58	447.733	17.88278	7.86038	3.51648	17.882784	7.90232	7.818437	50.11
17.6	447.733	17.89744	7.86038	3.51648	17.897436	7.90232	7.818437	49.82
17.62	447.733	17.91209	7.86038	3.51648	17.912088	7.90232	7.818437	49.82
17.64	446.489	17.91941	7.86038	3.50672	17.919414	7.90232	7.818437	49.52
17.66	446.489	17.94139	7.86038	3.50672	17.941392	7.90232	7.818437	50.11
17.68	446.489	17.94872	7.86038	3.50672	17.948718	7.90232	7.818437	49.52
17.7	447.733	17.96337	7.86038	3.51648	17.96337	7.90232	7.818437	49.52
17.72	447.733	17.9707	7.86038	3.51648	17.970696	7.90232	7.818437	48.64
17.74	450.22	18	7.86038	3.53602	18	7.90232	7.818437	49.82
17.76	451.464	18.03663	7.86038	3.54579	18.03663	7.90232	7.818437	49.82
17.78	451.464	18.05861	7.86038	3.54579	18.058608	7.90232	7.818437	49.82
17.8	451.464	18.08791	7.86038	3.54579	18.087912	7.90232	7.818437	50.11
17.82	450.22	18.10989	7.86038	3.53602	18.10989	7.90232	7.818437	49.82
17.84	448.976	18.13919	7.86038	3.52625	18.139194	7.90232	7.818437	49.82
17.86	448.976	18.15385	7.86038	3.52625	18.153846	7.90232	7.818437	49.82
17.88	447.733	18.1685	7.86038	3.51648	18.168498	7.90232	7.818437	49.52
17.9	447.733	18.19048	7.86038	3.51648	18.190476	7.90232	7.818437	49.82
17.92	447.733	18.1978	7.86038	3.51648	18.197802	7.90232	7.818437	49.82
17.94	441.514	18.1685	7.86038	3.46764	18.168498	7.90232	7.818437	47.77
17.96	448.976	18.22711	7.86038	3.52625	18.227106	7.90232	7.818437	49.82
17.98	448.976	18.24176	7.86038	3.52625	18.241758	7.90232	7.818437	49.82
18	451.464	18.26374	7.86038	3.54579	18.263736	7.90232	7.818437	50.11
18.02	451.464	18.28571	7.86038	3.54579	18.285714	7.90232	7.818437	49.82
18.04	451.464	18.30037	7.86038	3.54579	18.300366	7.90232	7.818437	49.52
18.06	451.464	18.34432	7.86038	3.54579	18.344322	7.90232	7.818437	49.52
18.08	451.464	18.37363	7.86038	3.54579	18.373626	7.90232	7.818437	49.52
18.1	451.464	18.40293	7.86038	3.54579	18.40293	7.90232	7.818437	50.11
18.12	450.22	18.41758	7.86038	3.53602	18.417582	7.90232	7.818437	50.11
18.14	448.976	18.43223	7.86038	3.52625	18.432234	7.90232	7.818437	50.11
18.16	448.976	18.44689	7.86038	3.52625	18.446886	7.90232	7.818437	49.82
18.18	448.976	18.47619	7.86038	3.52625	18.47619	7.90232	7.818437	50.11
18.2	447.733	18.48352	7.86038	3.51648	18.483516	7.90232	7.818437	49.82
18.22	448.976	18.50549	7.86038	3.52625	18.505495	7.90232	7.818437	50.11
18.24	448.976	18.50549	7.86038	3.52625	18.505495	7.90232	7.818437	49.82
18.26	450.22	18.52747	7.86038	3.53602	18.527473	7.90232	7.818437	49.82
18.28	451.464	18.54212	7.86038	3.54579	18.542125	7.90232	7.818437	49.52
18.3	452.707	18.5641	7.86038	3.55556	18.564103	7.90232	7.818437	50.11
18.32	452.707	18.58608	7.86038	3.55556	18.586081	7.90232	7.818437	49.52
18.34	452.707	18.61538	7.86038	3.55556	18.615385	7.90232	7.818437	49.52
18.36	452.707	18.64469	7.86038	3.55556	18.644689	7.90232	7.818437	50.11
18.38	451.464	18.67399	7.86038	3.54579	18.673993	7.90232	7.818437	49.82
18.4	450.22	18.69597	7.86038	3.53602	18.695971	7.90232	7.818437	49.52
18.42	450.22	18.71062	7.86038	3.53602	18.710623	7.90232	7.818437	49.52
18.44	448.976	18.7326	7.86038	3.52625	18.732601	7.90232	7.818437	49.52
18.46	448.976	18.74725	7.86038	3.52625	18.747253	7.90232	7.818437	49.52
18.48	448.976	18.7619	7.86038	3.52625	18.761905	7.90232	7.818437	49.82
18.5	450.22	18.78388	7.86038	3.53602	18.783883	7.90232	7.818437	50.11
18.52	445.245	18.77656	7.86038	3.49695	18.776557	7.90232	7.818437	49.52
18.54	450.22	18.80586	7.86038	3.53602	18.805861	7.90232	7.818437	50.11
18.56	451.464	18.82051	7.86038	3.54579	18.820513	7.90232	7.818437	50.11
18.58	452.707	18.84249	7.86038	3.55556	18.842491	7.90232	7.818437	49.82
18.6	451.464	18.85714	7.86038	3.54579	18.857143	7.90232	7.818437	49.52
18.62	453.951	18.89377	7.86038	3.56532	18.893773	7.90232	7.818437	50.11
18.64	452.707	18.91575	7.86038	3.55556	18.915751	7.90232	7.818437	49.82
18.66	452.707	18.94505	7.86038	3.55556	18.945055	7.90232	7.818437	49.52
18.68	452.707	18.97436	7.86038	3.55556	18.974359	7.90232	7.818437	50.11
18.7	451.464	18.98901	7.86038	3.54579	18.989011	7.90232	7.818437	49.23
18.72	450.22	19.01099	7.86038	3.53602	19.010989	7.90232	7.818437	49.82
18.74	451.464	19.03297	7.86038	3.54579	19.032967	7.90232	7.818437	50.11
18.76	450.22	19.04029	7.86038	3.53602	19.040293	7.90232	7.818437	49.82
18.78	450.22	19.05495	7.86038	3.53602	19.054945	7.90232	7.818437	49.82
18.8	448.976	19.06227	7.86038	3.52625	19.062271	7.90232	7.818437	49.52
18.82	448.976	19.07692	7.86038	3.52625	19.076923	7.90232	7.818437	49.52
18.84	451.464	19.0989	7.86038	3.54579	19.098901	7.90232	7.818437	49.52
18.86	451.464	19.12088	7.86038	3.54579	19.120879	7.90232	7.818437	49.52
18.88	453.951	19.14286	7.86038	3.56532	19.142857	7.90232	7.818437	49.82
18.9	453.951	19.17216	7.86038	3.56532	19.172161	7.90232	7.818437	49.82
18.92	453.951	19.20147	7.86038	3.56532	19.201465	7.90232	7.818437	50.11
18.94	452.707	19.23077	7.86038	3.55556	19.230769	7.90232	7.818437	50.11
18.96	452.707	19.25275	7.86038	3.55556	19.252747	7.90232	7.818437	50.11
18.98	450.22	19.2674	7.86038	3.53602	19.267399	7.90232	7.818437	49.52
19	448.976	19.28205	7.86038	3.52625	19.282051	7.90232	7.818437	49.52
19.02	448.976	19.2967	7.86038	3.52625	19.296703	7.90232	7.818437	49.52
19.04	448.976	19.32601	7.86038	3.52625	19.326007	7.90232	7.818437	50.11
19.06	448.976	19.33333	7.86038	3.52625	19.333333	7.90232	7.818437	49.82
19.08	448.976	19.34799	7.86038	3.52625	19.347985	7.90232	7.818437	49.52
19.1	450.22	19.36996	7.86038	3.53602	19.369963	7.90232	7.818437	49.82
19.12	450.22	19.38462	7.86038	3.53602	19.384615	7.90232	7.818437	50.11
19.14	451.464	19.40659	7.86038	3.54579	19.406593	7.90232	7.818437	49.82
19.16	451.464	19.42125	7.86038	3.54579	19.421245	7.90232	7.818437	50.11
19.18	452.707	19.44322	7.86038	3.55556	19.443223	7.90232	7.818437	49.82
19.2	452.707	19.47253	7.86038	3.55556	19.472527	7.90232	7.818437	49.82
19.22	451.464	19.50183	7.86038	3.54579	19.501832	7.90232	7.818437	49.82
19.24	451.464	19.53114	7.86038	3.54579	19.531136	7.90232	7.818437	50.11
19.26	450.22	19.55311	7.86038	3.53602	19.553114	7.90232	7.818437	50.11
19.28	450.22	19.57509	7.86038	3.53602	19.575092	7.90232	7.818437	50.11
19.3	448.976	19.58974	7.86038	3.52625	19.589744	7.90232	7.818437	49.82
19.32	447.733	19.59707	7.86038	3.51648	19.59707	7.90232	7.818437	49.52
19.34	448.976	19.61905	7.86038	3.52625	19.619048	7.90232	7.818437	50.11
19.36	447.733	19.62637	7.86038	3.51648	19.626374	7.90232	7.818437	49.52
19.38	447.733	19.64103	7.86038	3.51648	19.641026	7.90232	7.818437	49.52
19.4	448.976	19.663	7.86038	3.52625	19.663004	7.90232	7.818437	49.52
19.42	448.976	19.67766	7.86038	3.52625	19.677656	7.90232	7.818437	49.52
19.44	451.464	19.69963	7.86038	3.54579	19.699634	7.90232	7.818437	49.82
19.46	451.464	19.72161	7.86038	3.54579	19.721612	7.90232	7.818437	49.82
19.48	451.464	19.74359	7.86038	3.54579	19.74359	7.90232	7.818437	49.52
19.5	451.464	19.78022	7.86038	3.54579	19.78022	7.90232	7.818437	50.11
19.52	450.22	19.80952	7.86038	3.53602	19.809524	7.90232	7.818437	50.11
19.54	448.976	19.8315	7.86038	3.52625	19.831502	7.90232	7.818437	49.82
19.56	456.438	19.89011	7.86038	3.58486	19.89011	7.90232	7.818437	51.87
19.58	446.489	19.86813	7.86038	3.50672	19.868132	7.90232	7.818437	49.52
19.6	446.489	19.88278	7.86038	3.50672	19.882784	7.90232	7.818437	49.52
19.62	447.733	19.89744	7.86038	3.51648	19.897436	7.90232	7.818437	49.82
19.64	446.489	19.91209	7.86038	3.50672	19.912088	7.90232	7.818437	49.52
19.66	447.733	19.92674	7.86038	3.51648	19.92674	7.90232	7.818437	49.82

19.68	447.733	19.94139	7.86038	3.51648	19.941392	7.90232	7.818437	49.82
19.7	447.733	19.95604	7.86038	3.51648	19.956044	7.90232	7.818437	49.52
19.72	448.976	19.96337	7.86038	3.52625	19.96337	7.90232	7.818437	49.52
19.74	448.976	19.99267	7.86038	3.52625	19.992674	7.90232	7.818437	49.52
19.76	448.976	20.02198	7.86038	3.52625	20.021978	7.90232	7.818437	49.52
19.78	450.22	20.05128	7.86038	3.53602	20.051282	7.90232	7.818437	49.52
19.8	450.22	20.08059	7.86038	3.53602	20.080586	7.90232	7.818437	50.11
19.82	444.001	20.08791	7.86038	3.48718	20.087912	7.90232	7.818437	48.35
19.84	447.733	20.12454	7.86038	3.51648	20.124542	7.90232	7.818437	49.52
19.86	446.489	20.14652	7.86038	3.50672	20.14652	7.90232	7.818437	49.52
19.88	446.489	20.16117	7.86038	3.50672	20.161172	7.90232	7.818437	49.52
19.9	445.245	20.17582	7.86038	3.49695	20.175824	7.90232	7.818437	49.82
19.92	445.245	20.19048	7.86038	3.49695	20.190476	7.90232	7.818437	49.52
19.94	445.245	20.20513	7.86038	3.49695	20.205128	7.90232	7.818437	49.52
19.96	447.733	20.23443	7.86038	3.51648	20.234432	7.90232	7.818437	50.11
19.98	446.489	20.23443	7.86038	3.50672	20.234432	7.90232	7.818437	48.94
20	447.733	20.24908	7.86038	3.51648	20.249084	7.90232	7.818437	49.52
20.02	448.976	20.27839	7.86038	3.52625	20.278388	7.90232	7.818437	50.11
20.04	448.976	20.30769	7.86038	3.52625	20.307692	7.90232	7.818437	49.82
20.06	447.733	20.32967	7.86038	3.51648	20.32967	7.90232	7.818437	49.82
20.08	447.733	20.35897	7.86038	3.51648	20.358974	7.90232	7.818437	49.52
20.1	447.733	20.38828	7.86038	3.51648	20.388278	7.90232	7.818437	50.11
20.12	446.489	20.41026	7.86038	3.50672	20.410256	7.90232	7.818437	49.82
20.14	444.001	20.42491	7.86038	3.48718	20.424908	7.90232	7.818437	49.82
20.16	445.245	20.44689	7.86038	3.49695	20.446886	7.90232	7.818437	50.4
20.18	442.758	20.45421	7.86038	3.47741	20.454212	7.90232	7.818437	49.52
20.2	442.758	20.46886	7.86038	3.47741	20.468864	7.90232	7.818437	49.52
20.22	442.758	20.49084	7.86038	3.47741	20.490842	7.90232	7.818437	49.82
20.24	442.758	20.50549	7.86038	3.47741	20.505495	7.90232	7.818437	49.82
20.26	444.001	20.52015	7.86038	3.48718	20.520147	7.90232	7.818437	49.52
20.28	444.001	20.5348	7.86038	3.48718	20.534799	7.90232	7.818437	49.82
20.3	444.001	20.54945	7.86038	3.48718	20.549451	7.90232	7.818437	49.52
20.32	445.245	20.57875	7.86038	3.49695	20.578755	7.90232	7.818437	50.11
20.34	445.245	20.60073	7.86038	3.49695	20.600733	7.90232	7.818437	49.82
20.36	444.001	20.63004	7.86038	3.48718	20.630037	7.90232	7.818437	49.52
20.38	444.001	20.65934	7.86038	3.48718	20.659341	7.90232	7.818437	49.82
20.4	442.758	20.67399	7.86038	3.47741	20.673993	7.90232	7.818437	49.52
20.42	441.514	20.7033	7.86038	3.46764	20.703297	7.90232	7.818437	49.82
20.44	440.27	20.71795	7.86038	3.45788	20.717949	7.90232	7.818437	49.52
20.46	440.27	20.73993	7.86038	3.45788	20.739927	7.90232	7.818437	49.82
20.48	440.27	20.75458	7.86038	3.45788	20.754579	7.90232	7.818437	49.82
20.5	444.001	20.79121	7.86038	3.48718	20.791209	7.90232	7.818437	50.7
20.52	444.001	20.78388	7.86038	3.48718	20.783883	7.90232	7.818437	50.7
20.54	440.27	20.79853	7.86038	3.45788	20.798535	7.90232	7.818437	50.11
20.56	440.27	20.81319	7.86038	3.45788	20.813187	7.90232	7.818437	49.82
20.58	441.514	20.82784	7.86038	3.46764	20.827839	7.90232	7.818437	49.82
20.6	444.001	20.86447	7.86038	3.48718	20.864469	7.90232	7.818437	50.11
20.62	441.514	20.87912	7.86038	3.46764	20.879121	7.90232	7.818437	49.82
20.64	444.001	20.91575	7.86038	3.48718	20.915751	7.90232	7.818437	50.11
20.66	441.514	20.9304	7.86038	3.46764	20.930403	7.90232	7.818437	49.52
20.68	439.027	20.95971	7.86038	3.44811	20.959707	7.90232	7.818437	49.82
20.7	439.027	20.98168	7.86038	3.44811	20.981685	7.90232	7.818437	49.52
20.72	440.27	21.01832	7.86038	3.45788	21.018315	7.90232	7.818437	50.7
20.74	439.027	21.04029	7.86038	3.44811	21.040293	7.90232	7.818437	50.7
20.76	435.296	21.04029	7.86038	3.4188	21.040293	7.90232	7.818437	49.52
20.78	435.296	21.05495	7.86038	3.4188	21.054945	7.90232	7.818437	49.82
20.8	434.052	21.0696	7.86038	3.40904	21.069597	7.90232	7.818437	50.11
20.82	436.539	21.09158	7.86038	3.42857	21.091575	7.90232	7.818437	50.11
20.84	434.052	21.0989	7.86038	3.40904	21.098901	7.90232	7.818437	49.82
20.86	435.296	21.11355	7.86038	3.4188	21.113553	7.90232	7.818437	50.11
20.88	436.539	21.13553	7.86038	3.42857	21.135531	7.90232	7.818437	49.82
20.9	435.296	21.15018	7.86038	3.4188	21.150183	7.90232	7.818437	49.52
20.92	435.296	21.17216	7.86038	3.4188	21.172161	7.90232	7.818437	49.52
20.94	435.296	21.20147	7.86038	3.4188	21.201465	7.90232	7.818437	49.52
20.96	435.296	21.23077	7.86038	3.4188	21.230769	7.90232	7.818437	50.11
20.98	434.052	21.25275	7.86038	3.40904	21.252747	7.90232	7.818437	49.52
21	431.564	21.28205	7.86038	3.3895	21.282051	7.90232	7.818437	49.82

Stabilised red sand: confining pressure 100 kPa

IPC Global Universal Testing Machine

UTM_12 V2.00 Stress - Strain Test

Filename	D:\my research\Lab test Data\Triaxial\RSFALKD\UU-test\RSFALKD-triaxial-100kPa.B12
Operator	Mr.Peerapong Jitsangiam
Test type	Compression test
Notes/Comments	RSFALKD
Specimen shape	Cylindrical

Specimen Information

****

Identification	RSFALKD
Core/Sample Number	

Dimensions	Point 1	Point 2	Point 3	Point 4	Point 5	Point 6	Average	Std Dev.
Diameter (mm)	100						100	
Height (mm)	100						100	

Cross-Sectional area	7853.982
Volume	785398.2

Comments/Properties

Setup Parameters

****

Pre-load stress (kPa)	
Pre-load load (kN)	
Pre-load hold time (s)	
Confining pressure (kPa)	100
Confining hold time (s)	5
Dump pressure at end of test	Yes
Axial gauge length (mm)	100
Radial gauge length (mm)	
Advanced loading control	Disabled
Control Mode	Displacement (actuator)
Loading Rate (mm/s)	1
Termination Timer (sec)	0
% Unload	0
Minimum stress (kPa)	0
Minimum load (kN)	0
Termination Actuator (mm)	0
Termination Axial (mm)	250
Termination Radial (mm)	0

Calibration Information

****

Channel description	Filename	Transducer description	Span	Units	Date	Linearised
A: Axial Force	Y12346.CAR	STC5000 S/N: Y12346 +/-20kN	40	kN	7/12/2005	No
B: Actuator LVDT	941C-340.CAR	AC-15 S/N: M992941C-340 +/-15mm	30	mm	7/12/2005	No
C: Axial LVDT #1	83047.car	D6-05000A S/N: 83047 +/-5mm	10	mm	20/12/2005	Yes
D: Axial LVDT #2	83048.car	D6-05000A S/N: 83048 +/-5mm	10	mm	20/12/2005	Yes
E: Radial LVDT #1	S054041.CAR	IT2000AG S/N: S054041 +/-600kPa	1200	kPa	22/01/2004	No
F: Radial LVDT #2		Undefined/Not Used	1	?		No
G: Temperature Probe		Undefined/Not Used	1	?		No

H: Confining Pressure	S054041.CAR	IT2000AG S/N: S054041 +/-600kPa	1200	kPa	22/01/2004	No		
Test Results								
************								
Start date and time	Wednesday	December 20	2006	at 12:27 PM				
Timer (sec)	23							
Peak compressive stress (kPa)	1098.2							
Peak load (kN)	8.625							
Actuator strain at peak load (%)	6.022							
Actuator deformation at peak load (mm)	6.022							
Axial av. strain at peak load (%)	0							
Axial av. deform. at peak load (mm)	0							
Time	Stress	Actuator Strain	Axial average strain	Load	Actuator	Axial LVDT #1	Axial LVDT #2	Confining Pressure
(sec)	(kPa)	(%)	(%)	(kN)	(mm)	(mm)	(mm)	(kPa)
0	2.487	0	0	0.01954	0	0	0	99.63
0.04	52.235	0.3663	0	0.41026	0.3663	0	0	99.93
0.08	62.185	0.41758	0	0.4884	0.417582	0	0	99.93
0.12	70.891	0.46154	0	0.55678	0.461538	0	0	99.63
0.16	79.597	0.50549	0	0.62515	0.505495	0	0	99.93
0.2	89.547	0.54945	0	0.7033	0.549451	0	0	99.63
0.24	99.496	0.58608	0	0.78144	0.586081	0	0	99.93
0.28	110.689	0.63004	0	0.86935	0.630037	0	0	99.63
0.32	120.639	0.68132	0	0.9475	0.681319	0	0	99.93
0.36	131.832	0.72527	0	1.03541	0.725275	0	0	99.93
0.4	141.782	0.7619	0	1.11355	0.761905	0	0	99.34
0.44	151.732	0.79853	0	1.1917	0.798535	0	0	99.93
0.48	160.438	0.82784	0	1.26007	0.827839	0	0	99.05
0.52	171.631	0.87179	0	1.34799	0.871795	0	0	99.63
0.56	181.58	0.90842	0	1.42613	0.908425	0	0	99.34
0.6	194.017	0.95971	0	1.52381	0.959707	0	0	99.93
0.64	205.211	1.00366	0	1.61172	1.003663	0	0	99.63
0.68	216.404	1.04029	0	1.69963	1.040293	0	0	99.93
0.72	226.354	1.0696	0	1.77778	1.069597	0	0	99.34
0.76	240.034	1.12088	0	1.88523	1.120879	0	0	99.93
0.8	252.471	1.15751	0	1.98291	1.157509	0	0	99.93
0.84	264.908	1.19414	0	2.08059	1.194139	0	0	99.63
0.88	278.589	1.2381	0	2.18803	1.238095	0	0	99.93
0.92	292.27	1.28205	0	2.29548	1.282051	0	0	99.93
0.96	304.707	1.31136	0	2.39316	1.311355	0	0	99.93
1	317.144	1.34799	0	2.49084	1.347985	0	0	99.05
1.04	330.825	1.39194	0	2.59829	1.391941	0	0	99.93
1.08	345.749	1.4359	0	2.71551	1.435897	0	0	99.93
1.12	359.43	1.47253	0	2.82295	1.472527	0	0	99.93
1.16	373.11	1.51648	0	2.9304	1.516484	0	0	99.93
1.2	386.791	1.55311	0	3.03785	1.553114	0	0	99.93
1.24	399.228	1.59707	0	3.13553	1.59707	0	0	99.63
1.28	411.665	1.6337	0	3.23321	1.6337	0	0	99.93
1.32	425.346	1.67033	0	3.34066	1.67033	0	0	99.93
1.36	439.027	1.70696	0	3.44811	1.70696	0	0	99.93
1.4	452.707	1.75092	0	3.55556	1.750916	0	0	99.63
1.44	470.119	1.8022	0	3.69231	1.802198	0	0	100.22
1.48	482.556	1.8315	0	3.78999	1.831502	0	0	99.63
1.52	497.481	1.87546	0	3.9072	1.875458	0	0	99.93
1.56	512.405	1.91209	0	4.02442	1.912088	0	0	99.93

1.6	526.086	1.94872	0	4.13187	1.948718	0	0	99.93
1.64	539.767	1.99267	0	4.23932	1.992674	0	0	99.93
1.68	554.691	2.0293	0	4.35653	2.029304	0	0	99.93
1.72	569.615	2.07326	0	4.47375	2.07326	0	0	99.93
1.76	583.296	2.10989	0	4.5812	2.10989	0	0	99.93
1.8	596.977	2.14652	0	4.68864	2.14652	0	0	99.63
1.84	610.658	2.19048	0	4.79609	2.190476	0	0	99.93
1.88	624.338	2.22711	0	4.90354	2.227106	0	0	99.93
1.92	638.019	2.27839	0	5.01099	2.278388	0	0	99.93
1.96	650.456	2.30769	0	5.10867	2.307692	0	0	99.93
2	661.649	2.34432	0	5.19658	2.344322	0	0	99.63
2.04	674.086	2.38095	0	5.29426	2.380952	0	0	99.93
2.08	685.28	2.41758	0	5.38217	2.417582	0	0	99.93
2.12	696.473	2.46886	0	5.47009	2.468864	0	0	100.22
2.16	706.423	2.49084	0	5.54823	2.490842	0	0	99.63
2.2	715.128	2.51282	0	5.61661	2.512821	0	0	99.05
2.24	727.565	2.5641	0	5.71429	2.564103	0	0	99.93
2.28	738.759	2.60073	0	5.8022	2.600733	0	0	99.93
2.32	751.196	2.65201	0	5.89988	2.652015	0	0	100.51
2.36	758.658	2.67399	0	5.95849	2.673993	0	0	99.63
2.4	769.851	2.71795	0	6.0464	2.717949	0	0	100.22
2.44	778.557	2.75458	0	6.11477	2.754579	0	0	99.93
2.48	788.507	2.79121	0	6.19292	2.791209	0	0	99.93
2.52	797.213	2.82784	0	6.26129	2.827839	0	0	99.93
2.56	805.919	2.87179	0	6.32967	2.871795	0	0	99.93
2.6	814.625	2.90842	0	6.39805	2.908425	0	0	99.63
2.64	825.818	2.95238	0	6.48596	2.952381	0	0	100.51
2.68	830.793	2.98168	0	6.52503	2.981685	0	0	99.93
2.72	839.499	3.02564	0	6.59341	3.025641	0	0	99.63
2.76	846.961	3.06227	0	6.65201	3.062271	0	0	99.93
2.8	854.423	3.10623	0	6.71062	3.106227	0	0	99.93
2.84	864.373	3.15751	0	6.78877	3.157509	0	0	100.51
2.88	869.347	3.18681	0	6.82784	3.186813	0	0	99.93
2.92	875.566	3.21612	0	6.87668	3.216117	0	0	99.34
2.96	883.028	3.27473	0	6.93529	3.274725	0	0	99.93
3	890.49	3.31136	0	6.99389	3.311355	0	0	99.93
3.04	895.465	3.34799	0	7.03297	3.347985	0	0	99.63
3.08	902.927	3.39194	0	7.09158	3.391941	0	0	99.63
3.12	906.658	3.42125	0	7.12088	3.421245	0	0	99.34
3.16	915.364	3.47253	0	7.18926	3.472527	0	0	99.93
3.2	920.339	3.50916	0	7.22833	3.509158	0	0	99.93
3.24	925.314	3.54579	0	7.2674	3.545788	0	0	99.93
3.28	932.776	3.58974	0	7.32601	3.589744	0	0	99.63
3.32	937.751	3.6337	0	7.36508	3.6337	0	0	99.34
3.36	940.238	3.64835	0	7.38462	3.648352	0	0	98.75
3.4	948.944	3.70696	0	7.45299	3.70696	0	0	99.63
3.44	953.919	3.74359	0	7.49206	3.74359	0	0	99.93
3.48	958.894	3.79487	0	7.53114	3.794872	0	0	99.93
3.52	963.869	3.8315	0	7.57021	3.831502	0	0	99.93
3.56	968.844	3.86813	0	7.60928	3.868132	0	0	99.93
3.6	973.818	3.90476	0	7.64835	3.904762	0	0	99.93
3.64	978.793	3.94872	0	7.68742	3.948718	0	0	99.93
3.68	986.255	4.00733	0	7.74603	4.007326	0	0	100.51
3.72	986.255	4.0293	0	7.74603	4.029304	0	0	99.93
3.76	991.23	4.06593	0	7.7851	4.065934	0	0	99.63

3.8	994.961	4.10989	0	7.81441	4.10989	0	0	99.93
3.84	998.692	4.14652	0	7.84371	4.14652	0	0	99.63
3.88	1003.667	4.19048	0	7.88278	4.190476	0	0	99.93
3.92	1007.398	4.22711	0	7.91209	4.227106	0	0	99.93
3.96	1011.129	4.27106	0	7.94139	4.271062	0	0	99.93
4	1013.617	4.30769	0	7.96093	4.307692	0	0	99.63
4.04	1017.348	4.35165	0	7.99023	4.351648	0	0	99.63
4.08	1022.323	4.3956	0	8.0293	4.395604	0	0	99.93
4.12	1024.81	4.42491	0	8.04884	4.424908	0	0	99.93
4.16	1028.541	4.46886	0	8.07814	4.468864	0	0	99.34
4.2	1032.272	4.51282	0	8.10745	4.512821	0	0	99.93
4.24	1036.003	4.54945	0	8.13675	4.549451	0	0	99.93
4.28	1039.735	4.59341	0	8.16606	4.593407	0	0	99.93
4.32	1040.978	4.62271	0	8.17582	4.622711	0	0	99.63
4.36	1044.709	4.66667	0	8.20513	4.666667	0	0	99.93
4.4	1047.197	4.71062	0	8.22466	4.710623	0	0	99.93
4.44	1049.684	4.74725	0	8.2442	4.747253	0	0	99.63
4.48	1052.172	4.78388	0	8.26374	4.783883	0	0	99.93
4.52	1054.659	4.82784	0	8.28327	4.827839	0	0	99.63
4.56	1058.39	4.87179	0	8.31258	4.871795	0	0	99.93
4.6	1059.634	4.9011	0	8.32234	4.901099	0	0	99.93
4.64	1063.365	4.95238	0	8.35165	4.952381	0	0	99.93
4.68	1065.852	4.98901	0	8.37118	4.989011	0	0	99.93
4.72	1068.34	5.02564	0	8.39072	5.025641	0	0	99.63
4.76	1070.827	5.0696	0	8.41026	5.069597	0	0	99.63
4.8	1072.071	5.10623	0	8.42002	5.106227	0	0	99.93
4.84	1074.558	5.15018	0	8.43956	5.150183	0	0	99.93
4.88	1077.046	5.18681	0	8.4591	5.186813	0	0	99.93
4.92	1078.289	5.22344	0	8.46886	5.223443	0	0	99.93
4.96	1079.533	5.2674	0	8.47863	5.267399	0	0	99.93
5	1082.02	5.31136	0	8.49817	5.311355	0	0	99.93
5.04	1084.508	5.34799	0	8.5177	5.347985	0	0	99.93
5.08	1084.508	5.38462	0	8.5177	5.384615	0	0	99.93
5.12	1090.726	5.45055	0	8.56654	5.450549	0	0	100.81
5.16	1088.239	5.47253	0	8.54701	5.472527	0	0	99.93
5.2	1090.726	5.51648	0	8.56654	5.516484	0	0	99.63
5.24	1089.483	5.54579	0	8.55678	5.545788	0	0	99.63
5.28	1091.97	5.58974	0	8.57631	5.589744	0	0	99.63
5.32	1093.214	5.64103	0	8.58608	5.641026	0	0	99.93
5.36	1093.214	5.67766	0	8.58608	5.677656	0	0	99.63
5.4	1091.97	5.70696	0	8.57631	5.70696	0	0	99.34
5.44	1094.457	5.75824	0	8.59585	5.758242	0	0	99.93
5.48	1095.701	5.8022	0	8.60562	5.802198	0	0	99.93
5.52	1095.701	5.83883	0	8.60562	5.838828	0	0	99.93
5.56	1095.701	5.88278	0	8.60562	5.882784	0	0	99.93
5.6	1096.945	5.93407	0	8.61538	5.934066	0	0	99.93
5.64	1095.701	5.9707	0	8.60562	5.970696	0	0	99.63
5.68	1098.189	6.02198	0	8.62515	6.021978	0	0	99.63
5.72	1095.701	6.05861	0	8.60562	6.058608	0	0	99.93
5.76	1096.945	6.10989	0	8.61538	6.10989	0	0	99.93
5.8	1098.189	6.16117	0	8.62515	6.161172	0	0	100.81
5.84	1094.457	6.19048	0	8.59585	6.190476	0	0	99.93
5.88	1094.457	6.23443	0	8.59585	6.234432	0	0	100.51
5.92	1090.726	6.26374	0	8.56654	6.263736	0	0	99.63
5.96	1089.483	6.30037	0	8.55678	6.300366	0	0	99.93

6	1093.214	6.37363	0	8.58608	6.373626	0	0	101.1
6.04	1085.752	6.37363	0	8.52747	6.373626	0	0	99.63
6.08	1085.752	6.41026	0	8.52747	6.410256	0	0	99.63
6.12	1085.752	6.45421	0	8.52747	6.454212	0	0	99.93
6.16	1084.508	6.49084	0	8.5177	6.490842	0	0	99.63
6.2	1083.264	6.5348	0	8.50794	6.534799	0	0	99.93
6.24	1082.02	6.58608	0	8.49817	6.586081	0	0	99.93
6.28	1079.533	6.63736	0	8.47863	6.637363	0	0	100.51
6.32	1075.802	6.68132	0	8.44933	6.681319	0	0	99.93
6.36	1069.583	6.72527	0	8.40049	6.725275	0	0	99.93
6.4	1064.609	6.75458	0	8.36142	6.754579	0	0	99.63
6.44	1060.877	6.80586	0	8.33211	6.805861	0	0	99.93
6.48	1054.659	6.83516	0	8.28327	6.835165	0	0	99.93
6.52	1050.928	6.87912	0	8.25397	6.879121	0	0	99.93
6.56	1045.953	6.91575	0	8.2149	6.915751	0	0	99.93
6.6	1042.222	6.95238	0	8.18559	6.952381	0	0	99.93
6.64	1037.247	6.99634	0	8.14652	6.996337	0	0	99.93
6.68	1032.272	7.03297	0	8.10745	7.032967	0	0	99.93
6.72	1027.298	7.0696	0	8.06838	7.069597	0	0	99.93
6.76	1019.835	7.11355	0	8.00977	7.113553	0	0	99.93
6.8	1013.617	7.15751	0	7.96093	7.157509	0	0	99.93
6.84	1007.398	7.19414	0	7.91209	7.194139	0	0	99.93
6.88	999.936	7.2381	0	7.85348	7.238095	0	0	99.93
6.92	993.718	7.28205	0	7.80464	7.282051	0	0	99.93
6.96	986.255	7.31868	0	7.74603	7.318681	0	0	99.93
7	978.793	7.35531	0	7.68742	7.355311	0	0	99.63
7.04	973.818	7.39927	0	7.64835	7.399267	0	0	100.22
7.08	966.356	7.42125	0	7.58974	7.421245	0	0	99.63
7.12	961.381	7.44322	0	7.55067	7.443223	0	0	99.34
7.16	958.894	7.47253	0	7.53114	7.472527	0	0	99.93
7.2	956.407	7.50916	0	7.5116	7.509158	0	0	99.93
7.24	953.919	7.56044	0	7.49206	7.56044	0	0	99.93
7.28	947.701	7.61172	0	7.44322	7.611722	0	0	99.63
7.32	937.751	7.68498	0	7.36508	7.684982	0	0	99.93
7.36	926.558	7.75092	0	7.27717	7.750916	0	0	99.93
7.4	912.877	7.81685	0	7.16972	7.81685	0	0	99.93
7.44	902.927	7.85348	0	7.09158	7.85348	0	0	99.93
7.48	892.978	7.87546	0	7.01343	7.875458	0	0	99.63
7.52	885.516	7.89011	0	6.95482	7.89011	0	0	99.63
7.56	883.028	7.91209	0	6.93529	7.912088	0	0	99.93
7.6	879.297	7.91941	0	6.90598	7.919414	0	0	99.34
7.64	880.541	7.94139	0	6.91575	7.941392	0	0	99.93
7.68	883.028	7.95604	0	6.93529	7.956044	0	0	99.63
7.72	886.759	7.98535	0	6.96459	7.985348	0	0	99.93
7.76	889.247	8.03663	0	6.98413	8.03663	0	0	99.93
7.8	880.541	8.13919	0	6.91575	8.139194	0	0	99.93
7.84	860.642	8.27106	0	6.75946	8.271062	0	0	99.63
7.88	835.767	8.3663	0	6.5641	8.3663	0	0	99.93
7.92	814.625	8.3956	0	6.39805	8.395604	0	0	99.93
7.96	799.7	8.40293	0	6.28083	8.40293	0	0	99.63
8	790.994	8.40293	0	6.21245	8.40293	0	0	99.63
8.04	789.751	8.42491	0	6.20269	8.424908	0	0	100.22
8.08	787.263	8.41026	0	6.18315	8.410256	0	0	99.63
8.12	788.507	8.3956	0	6.19292	8.395604	0	0	99.34
8.16	794.725	8.42491	0	6.24176	8.424908	0	0	99.63

8.2	805.919	8.43956	0	6.32967	8.43956	0	0	100.22
8.24	817.112	8.46154	0	6.41758	8.461538	0	0	99.93
8.28	824.574	8.55678	0	6.47619	8.556777	0	0	100.51
8.32	789.751	8.78388	0	6.20269	8.783883	0	0	99.93
8.36	731.297	8.99634	0	5.74359	8.996337	0	0	99.93
8.4	687.767	9.01099	0	5.40171	9.010989	0	0	100.51
8.44	652.943	8.98901	0	5.12821	8.989011	0	0	99.93
8.48	630.557	8.98168	0	4.95238	8.981685	0	0	99.63
8.52	616.876	8.97436	0	4.84493	8.974359	0	0	99.93
8.56	606.926	8.96703	0	4.76679	8.967033	0	0	99.34
8.6	603.195	8.96703	0	4.73748	8.967033	0	0	99.93
8.64	605.683	8.97436	0	4.75702	8.974359	0	0	100.22
8.68	604.439	8.96703	0	4.74725	8.967033	0	0	99.63
8.72	616.876	8.99634	0	4.84493	8.996337	0	0	101.1
8.76	624.338	8.97436	0	4.90354	8.974359	0	0	99.93
8.8	642.994	8.98168	0	5.05006	8.981685	0	0	99.93
8.84	667.868	8.98901	0	5.24542	8.989011	0	0	99.93
8.88	698.96	9.01099	0	5.48962	9.010989	0	0	99.93
8.92	726.322	9.07692	0	5.70452	9.076923	0	0	99.63
8.96	686.523	9.45788	0	5.39194	9.457875	0	0	99.93
9	645.481	9.58242	0	5.0696	9.582418	0	0	100.51
9.04	616.876	9.56777	0	4.84493	9.567766	0	0	99.93
9.08	598.22	9.56777	0	4.69841	9.567766	0	0	99.93
9.12	583.296	9.55311	0	4.5812	9.553114	0	0	99.34
9.16	575.834	9.56044	0	4.52259	9.56044	0	0	99.34
9.2	573.346	9.55311	0	4.50305	9.553114	0	0	99.34
9.24	573.346	9.55311	0	4.50305	9.553114	0	0	99.63
9.28	575.834	9.56044	0	4.52259	9.56044	0	0	99.34
9.32	585.783	9.56777	0	4.60073	9.567766	0	0	100.22
9.36	596.977	9.56777	0	4.68864	9.567766	0	0	99.93
9.4	616.876	9.58242	0	4.84493	9.582418	0	0	100.22
9.44	641.75	9.59707	0	5.04029	9.59707	0	0	99.93
9.48	654.187	9.70696	0	5.13797	9.70696	0	0	99.93
9.52	634.288	9.92674	0	4.98168	9.92674	0	0	100.22
9.56	616.876	9.99267	0	4.84493	9.992674	0	0	99.93
9.6	605.683	10	0	4.75702	10	0	0	99.93
9.64	599.464	10.01465	0	4.70818	10.014652	0	0	99.93
9.68	598.22	10.01465	0	4.69841	10.014652	0	0	99.93
9.72	599.464	10.02198	0	4.70818	10.021978	0	0	99.93
9.76	604.439	10.0293	0	4.74725	10.029304	0	0	99.34
9.8	611.901	10.04396	0	4.80586	10.043956	0	0	99.93
9.84	620.607	10.08059	0	4.87424	10.080586	0	0	99.63
9.88	618.12	10.18315	0	4.8547	10.18315	0	0	99.63
9.92	610.658	10.27839	0	4.79609	10.278388	0	0	99.93
9.96	603.195	10.32234	0	4.73748	10.322344	0	0	99.93
10	598.22	10.35165	0	4.69841	10.351648	0	0	99.93
10.04	598.22	10.38828	0	4.69841	10.388278	0	0	100.51
10.08	595.733	10.38828	0	4.67888	10.388278	0	0	99.93
10.12	594.489	10.3956	0	4.66911	10.395604	0	0	99.34
10.16	600.708	10.43223	0	4.71795	10.432234	0	0	99.93
10.2	604.439	10.46886	0	4.74725	10.468864	0	0	99.93
10.24	604.439	10.5348	0	4.74725	10.534799	0	0	99.93
10.28	600.708	10.60806	0	4.71795	10.608059	0	0	99.93
10.32	595.733	10.65934	0	4.67888	10.659341	0	0	99.93
10.36	592.002	10.7033	0	4.64957	10.703297	0	0	99.63

10.4	592.002	10.74725	0	4.64957	10.747253	0	0	100.51
10.44	588.271	10.74725	0	4.62027	10.747253	0	0	99.34
10.48	589.515	10.77656	0	4.63004	10.776557	0	0	99.93
10.52	592.002	10.81319	0	4.64957	10.813187	0	0	100.22
10.56	593.246	10.84249	0	4.65934	10.842491	0	0	99.34
10.6	593.246	10.9011	0	4.65934	10.901099	0	0	99.93
10.64	592.002	10.95971	0	4.64957	10.959707	0	0	99.93
10.68	588.271	11.01099	0	4.62027	11.010989	0	0	99.93
10.72	587.027	11.05495	0	4.6105	11.054945	0	0	99.93
10.76	587.027	11.08425	0	4.6105	11.084249	0	0	100.22
10.8	584.54	11.0989	0	4.59096	11.098901	0	0	99.93
10.84	585.783	11.12821	0	4.60073	11.128205	0	0	99.93
10.88	588.271	11.17216	0	4.62027	11.172161	0	0	99.63
10.92	588.271	11.22344	0	4.62027	11.223443	0	0	99.93
10.96	588.271	11.28205	0	4.62027	11.282051	0	0	99.93
11	583.296	11.33333	0	4.5812	11.333333	0	0	99.63
11.04	580.809	11.37729	0	4.56166	11.377289	0	0	99.63
11.08	579.565	11.40659	0	4.55189	11.406593	0	0	99.93
11.12	580.809	11.4359	0	4.56166	11.435897	0	0	100.22
11.16	579.565	11.4652	0	4.55189	11.465201	0	0	99.93
11.2	580.809	11.48718	0	4.56166	11.487179	0	0	99.93
11.24	585.783	11.54579	0	4.60073	11.545788	0	0	100.51
11.28	583.296	11.58242	0	4.5812	11.582418	0	0	99.63
11.32	580.809	11.64103	0	4.56166	11.641026	0	0	99.93
11.36	579.565	11.69963	0	4.55189	11.699634	0	0	99.93
11.4	577.078	11.72894	0	4.53236	11.728938	0	0	99.93
11.44	578.321	11.76557	0	4.54212	11.765568	0	0	99.93
11.48	577.078	11.78755	0	4.53236	11.787546	0	0	99.93
11.52	575.834	11.81685	0	4.52259	11.81685	0	0	99.63
11.56	577.078	11.85348	0	4.53236	11.85348	0	0	99.34
11.6	578.321	11.89744	0	4.54212	11.897436	0	0	99.34
11.64	573.346	11.92674	0	4.50305	11.92674	0	0	98.17
11.68	577.078	12.00733	0	4.53236	12.007326	0	0	99.63
11.72	574.59	12.05128	0	4.51282	12.051282	0	0	99.93
11.76	573.346	12.08059	0	4.50305	12.080586	0	0	99.93
11.8	572.103	12.10989	0	4.49328	12.10989	0	0	99.93
11.84	572.103	12.13919	0	4.49328	12.139194	0	0	99.63
11.88	574.59	12.18315	0	4.51282	12.18315	0	0	99.93
11.92	575.834	12.21245	0	4.52259	12.212454	0	0	99.63
11.96	577.078	12.26374	0	4.53236	12.263736	0	0	99.63
12	579.565	12.32967	0	4.55189	12.32967	0	0	100.51
12.04	573.346	12.37363	0	4.50305	12.373626	0	0	99.63
12.08	570.859	12.41026	0	4.48352	12.410256	0	0	99.93
12.12	569.615	12.43956	0	4.47375	12.43956	0	0	99.34
12.16	570.859	12.46886	0	4.48352	12.468864	0	0	99.93
12.2	568.372	12.49084	0	4.46398	12.490842	0	0	99.34
12.24	569.615	12.52747	0	4.47375	12.527473	0	0	99.34
12.28	573.346	12.57875	0	4.50305	12.578755	0	0	100.22
12.32	569.615	12.60806	0	4.47375	12.608059	0	0	98.75
12.36	572.103	12.68864	0	4.49328	12.688645	0	0	99.93
12.4	568.372	12.7326	0	4.46398	12.732601	0	0	99.93
12.44	567.128	12.76923	0	4.45421	12.769231	0	0	99.93
12.48	565.884	12.79121	0	4.44444	12.791209	0	0	99.63
12.52	567.128	12.82051	0	4.45421	12.820513	0	0	99.63
12.56	565.884	12.84982	0	4.44444	12.849817	0	0	99.63

12.6	572.103	12.91575	0	4.49328	12.915751	0	0	101.1
12.64	568.372	12.95238	0	4.46398	12.952381	0	0	99.93
12.68	569.615	12.99634	0	4.47375	12.996337	0	0	99.93
12.72	564.641	13.04029	0	4.43468	13.040293	0	0	99.63
12.76	563.397	13.07692	0	4.42491	13.076923	0	0	99.93
12.8	562.153	13.11355	0	4.41514	13.113553	0	0	99.93
12.84	560.909	13.13553	0	4.40537	13.135531	0	0	99.63
12.88	560.909	13.15751	0	4.40537	13.157509	0	0	99.34
12.92	565.884	13.19414	0	4.44444	13.194139	0	0	99.63
12.96	567.128	13.25275	0	4.45421	13.252747	0	0	99.93
13	565.884	13.31136	0	4.44444	13.311355	0	0	99.93
13.04	562.153	13.36264	0	4.41514	13.362637	0	0	99.34
13.08	559.666	13.41392	0	4.3956	13.413919	0	0	99.63
13.12	557.178	13.4359	0	4.37607	13.435897	0	0	99.34
13.16	557.178	13.47253	0	4.37607	13.472527	0	0	99.63
13.2	557.178	13.49451	0	4.37607	13.494505	0	0	99.93
13.24	557.178	13.50916	0	4.37607	13.509158	0	0	98.75
13.28	562.153	13.55311	0	4.41514	13.553114	0	0	99.93
13.32	563.397	13.59707	0	4.42491	13.59707	0	0	99.63
13.36	563.397	13.67033	0	4.42491	13.67033	0	0	99.93
13.4	559.666	13.72161	0	4.3956	13.721612	0	0	99.63
13.44	557.178	13.76557	0	4.37607	13.765568	0	0	99.63
13.48	554.691	13.8022	0	4.35653	13.802198	0	0	99.93
13.52	554.691	13.8315	0	4.35653	13.831502	0	0	99.63
13.56	553.447	13.84615	0	4.34676	13.846154	0	0	99.93
13.6	555.935	13.87546	0	4.3663	13.875458	0	0	99.93
13.64	559.666	13.91209	0	4.3956	13.912088	0	0	99.93
13.68	560.909	13.95604	0	4.40537	13.956044	0	0	99.63
13.72	559.666	14.03663	0	4.3956	14.03663	0	0	100.51
13.76	557.178	14.08059	0	4.37607	14.080586	0	0	99.93
13.8	557.178	14.13187	0	4.37607	14.131868	0	0	100.51
13.84	552.204	14.15385	0	4.337	14.153846	0	0	99.93
13.88	553.447	14.19048	0	4.34676	14.190476	0	0	99.93
13.92	552.204	14.20513	0	4.337	14.205128	0	0	99.63
13.96	555.935	14.24176	0	4.3663	14.241758	0	0	100.22
14	557.178	14.26374	0	4.37607	14.263736	0	0	99.63
14.04	558.422	14.32234	0	4.38584	14.322344	0	0	99.93
14.08	555.935	14.3956	0	4.3663	14.395604	0	0	99.93
14.12	550.96	14.45421	0	4.32723	14.454212	0	0	99.93
14.16	548.472	14.49084	0	4.30769	14.490842	0	0	99.93
14.2	548.472	14.5348	0	4.30769	14.534799	0	0	100.51
14.24	544.741	14.5348	0	4.27839	14.534799	0	0	99.63
14.28	547.229	14.5641	0	4.29792	14.564103	0	0	100.22
14.32	547.229	14.57875	0	4.29792	14.578755	0	0	99.93
14.36	550.96	14.62271	0	4.32723	14.622711	0	0	99.63
14.4	549.716	14.68864	0	4.31746	14.688645	0	0	99.93
14.44	548.472	14.74725	0	4.30769	14.747253	0	0	99.93
14.48	547.229	14.79853	0	4.29792	14.798535	0	0	99.93
14.52	543.498	14.82784	0	4.26862	14.827839	0	0	99.63
14.56	541.01	14.84982	0	4.24908	14.849817	0	0	99.34
14.6	542.254	14.87912	0	4.25885	14.879121	0	0	99.63
14.64	544.741	14.91575	0	4.27839	14.915751	0	0	99.93
14.68	547.229	14.94505	0	4.29792	14.945055	0	0	99.93
14.72	547.229	14.99634	0	4.29792	14.996337	0	0	99.93
14.76	544.741	15.06227	0	4.27839	15.062271	0	0	99.63

14.8	543.498	15.12821	0	4.26862	15.128205	0	0	99.93
14.84	538.523	15.15751	0	4.22955	15.157509	0	0	99.63
14.88	537.279	15.18681	0	4.21978	15.186813	0	0	99.93
14.92	536.035	15.20147	0	4.21001	15.201465	0	0	99.34
14.96	538.523	15.23077	0	4.22955	15.230769	0	0	99.63
15	541.01	15.26007	0	4.24908	15.260073	0	0	99.93
15.04	542.254	15.2967	0	4.25885	15.296703	0	0	99.93
15.08	543.498	15.36264	0	4.26862	15.362637	0	0	99.93
15.12	542.254	15.42857	0	4.25885	15.428571	0	0	99.93
15.16	538.523	15.4652	0	4.22955	15.465201	0	0	99.93
15.2	537.279	15.50916	0	4.21978	15.509158	0	0	99.93
15.24	537.279	15.53846	0	4.21978	15.538462	0	0	100.22
15.28	536.035	15.56044	0	4.21001	15.56044	0	0	99.93
15.32	538.523	15.58974	0	4.22955	15.589744	0	0	99.93
15.36	542.254	15.6337	0	4.25885	15.6337	0	0	100.51
15.4	541.01	15.68498	0	4.24908	15.684982	0	0	99.93
15.44	538.523	15.74359	0	4.22955	15.74359	0	0	99.93
15.48	537.279	15.78022	0	4.21978	15.78022	0	0	99.63
15.52	534.792	15.82418	0	4.20024	15.824176	0	0	99.93
15.56	533.548	15.85348	0	4.19048	15.85348	0	0	99.63
15.6	532.304	15.88278	0	4.18071	15.882784	0	0	99.63
15.64	532.304	15.90476	0	4.18071	15.904762	0	0	99.63
15.68	543.498	15.99267	0	4.26862	15.992674	0	0	102.27
15.72	537.279	15.98535	0	4.21978	15.985348	0	0	99.93
15.76	536.035	16.05128	0	4.21001	16.051282	0	0	99.93
15.8	533.548	16.10256	0	4.19048	16.102564	0	0	99.93
15.84	531.061	16.13919	0	4.17094	16.139194	0	0	99.34
15.88	531.061	16.1685	0	4.17094	16.168498	0	0	99.93
15.92	528.573	16.1978	0	4.1514	16.197802	0	0	99.63
15.96	529.817	16.23443	0	4.16117	16.234432	0	0	99.93
16	531.061	16.26374	0	4.17094	16.263736	0	0	99.93
16.04	532.304	16.30037	0	4.18071	16.300366	0	0	100.22
16.08	534.792	16.35165	0	4.20024	16.351648	0	0	99.93
16.12	534.792	16.42491	0	4.20024	16.424908	0	0	100.22
16.16	532.304	16.47619	0	4.18071	16.47619	0	0	100.51
16.2	528.573	16.50549	0	4.1514	16.505495	0	0	99.63
16.24	524.842	16.52747	0	4.1221	16.527473	0	0	98.75
16.28	527.329	16.55678	0	4.14164	16.556777	0	0	99.34
16.32	527.329	16.59341	0	4.14164	16.593407	0	0	99.93
16.36	527.329	16.60806	0	4.14164	16.608059	0	0	99.05
16.4	529.817	16.67399	0	4.16117	16.673993	0	0	99.93
16.44	531.061	16.72527	0	4.17094	16.725275	0	0	99.63
16.48	528.573	16.78388	0	4.1514	16.783883	0	0	99.93
16.52	527.329	16.82784	0	4.14164	16.827839	0	0	99.93
16.56	524.842	16.85714	0	4.1221	16.857143	0	0	99.93
16.6	524.842	16.87912	0	4.1221	16.879121	0	0	99.93
16.64	524.842	16.90842	0	4.1221	16.908425	0	0	99.63
16.68	528.573	16.94505	0	4.1514	16.945055	0	0	99.93
16.72	528.573	16.98168	0	4.1514	16.981685	0	0	99.63
16.76	534.792	17.0696	0	4.20024	17.069597	0	0	101.1
16.8	527.329	17.09158	0	4.14164	17.091575	0	0	99.93
16.84	527.329	17.14286	0	4.14164	17.142857	0	0	100.22
16.88	524.842	17.17216	0	4.1221	17.172161	0	0	99.63
16.92	523.598	17.19414	0	4.11233	17.194139	0	0	99.93
16.96	524.842	17.23077	0	4.1221	17.230769	0	0	99.93

17	526.086	17.26007	0	4.13187	17.260073	0	0	99.93
17.04	527.329	17.2967	0	4.14164	17.296703	0	0	99.34
17.08	528.573	17.36264	0	4.1514	17.362637	0	0	99.93
17.12	527.329	17.42857	0	4.14164	17.428571	0	0	99.93
17.16	523.598	17.4652	0	4.11233	17.465201	0	0	99.63
17.2	522.355	17.50183	0	4.10256	17.501832	0	0	99.93
17.24	521.111	17.51648	0	4.0928	17.516484	0	0	99.93
17.28	523.598	17.56044	0	4.11233	17.56044	0	0	100.51
17.32	522.355	17.58242	0	4.10256	17.582418	0	0	99.93
17.36	523.598	17.62637	0	4.11233	17.626374	0	0	99.63
17.4	523.598	17.67766	0	4.11233	17.677656	0	0	99.93
17.44	522.355	17.72894	0	4.10256	17.728938	0	0	99.93
17.48	521.111	17.78022	0	4.0928	17.78022	0	0	100.22
17.52	518.624	17.80952	0	4.07326	17.809524	0	0	99.93
17.56	518.624	17.83883	0	4.07326	17.838828	0	0	99.93
17.6	516.136	17.84615	0	4.05372	17.846154	0	0	99.34
17.64	521.111	17.89744	0	4.0928	17.897436	0	0	99.93
17.68	522.355	17.95604	0	4.10256	17.956044	0	0	100.22
17.72	517.38	18	0	4.06349	18	0	0	99.34
17.76	517.38	18.05128	0	4.06349	18.051282	0	0	99.93
17.8	514.892	18.08791	0	4.04396	18.087912	0	0	99.63
17.84	513.649	18.11722	0	4.03419	18.117216	0	0	99.93
17.88	514.892	18.15385	0	4.04396	18.153846	0	0	99.93
17.92	514.892	18.17582	0	4.04396	18.175824	0	0	99.93
17.96	518.624	18.21245	0	4.07326	18.212454	0	0	99.93
18	518.624	18.26374	0	4.07326	18.263736	0	0	99.93
18.04	513.649	18.31502	0	4.03419	18.315018	0	0	99.05
18.08	513.649	18.38095	0	4.03419	18.380952	0	0	99.93
18.12	513.649	18.42491	0	4.03419	18.424908	0	0	100.22
18.16	509.918	18.43956	0	4.00488	18.43956	0	0	99.93
18.2	509.918	18.46886	0	4.00488	18.468864	0	0	99.63
18.24	511.161	18.49817	0	4.01465	18.498168	0	0	99.93
18.28	513.649	18.52747	0	4.03419	18.527473	0	0	99.93
18.32	514.892	18.57143	0	4.04396	18.571429	0	0	99.93
18.36	512.405	18.61538	0	4.02442	18.615385	0	0	99.05
18.4	513.649	18.68864	0	4.03419	18.688645	0	0	99.93
18.44	512.405	18.7326	0	4.02442	18.732601	0	0	99.93
18.48	513.649	18.77656	0	4.03419	18.776557	0	0	100.51
18.52	511.161	18.78388	0	4.01465	18.783883	0	0	99.93
18.56	512.405	18.82051	0	4.02442	18.820513	0	0	99.63
18.6	514.892	18.86447	0	4.04396	18.864469	0	0	99.93
18.64	516.136	18.90842	0	4.05372	18.908425	0	0	99.93
18.68	514.892	18.95971	0	4.04396	18.959707	0	0	99.93
18.72	513.649	19.01099	0	4.03419	19.010989	0	0	99.93
18.76	511.161	19.04762	0	4.01465	19.047619	0	0	99.93
18.8	509.918	19.07692	0	4.00488	19.076923	0	0	99.63
18.84	511.161	19.10623	0	4.01465	19.106227	0	0	99.93
18.88	516.136	19.15018	0	4.05372	19.150183	0	0	100.81
18.92	514.892	19.17949	0	4.04396	19.179487	0	0	99.93
18.96	514.892	19.23077	0	4.04396	19.230769	0	0	99.93
19	514.892	19.2967	0	4.04396	19.296703	0	0	100.51
19.04	511.161	19.33333	0	4.01465	19.333333	0	0	99.93
19.08	509.918	19.35531	0	4.00488	19.355311	0	0	99.93
19.12	508.674	19.39194	0	3.99512	19.391941	0	0	99.63
19.16	508.674	19.42125	0	3.99512	19.421245	0	0	99.93

19.2	511.161	19.45055	0	4.01465	19.450549	0	0	99.93
19.24	511.161	19.49451	0	4.01465	19.494505	0	0	99.34
19.28	511.161	19.55311	0	4.01465	19.553114	0	0	99.63
19.32	509.918	19.6044	0	4.00488	19.604396	0	0	99.93
19.36	508.674	19.663	0	3.99512	19.663004	0	0	100.81
19.4	504.943	19.67766	0	3.96581	19.677656	0	0	99.34
19.44	504.943	19.70696	0	3.96581	19.70696	0	0	99.63
19.48	504.943	19.72894	0	3.96581	19.728938	0	0	99.63
19.52	508.674	19.75824	0	3.99512	19.758242	0	0	99.63
19.56	511.161	19.82418	0	4.01465	19.824176	0	0	100.22
19.6	507.43	19.88278	0	3.98535	19.882784	0	0	99.93
19.64	507.43	19.93407	0	3.98535	19.934066	0	0	100.22
19.68	502.455	19.9707	0	3.94628	19.970696	0	0	99.93
19.72	501.212	19.99267	0	3.93651	19.992674	0	0	99.63
19.76	499.968	20.01465	0	3.92674	20.014652	0	0	99.63
19.8	503.699	20.04396	0	3.95604	20.043956	0	0	99.93
19.84	506.187	20.08059	0	3.97558	20.080586	0	0	99.93
19.88	507.43	20.13919	0	3.98535	20.139194	0	0	99.93
19.92	502.455	20.18315	0	3.94628	20.18315	0	0	99.34
19.96	503.699	20.24908	0	3.95604	20.249084	0	0	99.63
20	499.968	20.27839	0	3.92674	20.278388	0	0	99.63
20.04	499.968	20.30769	0	3.92674	20.307692	0	0	99.63
20.08	499.968	20.32967	0	3.92674	20.32967	0	0	99.93
20.12	502.455	20.3663	0	3.94628	20.3663	0	0	99.93
20.16	504.943	20.40293	0	3.96581	20.40293	0	0	99.93
20.2	504.943	20.46154	0	3.96581	20.461538	0	0	99.63
20.24	504.943	20.52747	0	3.96581	20.527473	0	0	100.22
20.28	502.455	20.5641	0	3.94628	20.564103	0	0	99.93
20.32	499.968	20.60073	0	3.92674	20.600733	0	0	100.51
20.36	498.724	20.61538	0	3.91697	20.615385	0	0	99.34
20.4	501.212	20.65201	0	3.93651	20.652015	0	0	99.93
20.44	503.699	20.68132	0	3.95604	20.681319	0	0	99.93
20.48	503.699	20.7326	0	3.95604	20.732601	0	0	99.63
20.52	502.455	20.79853	0	3.94628	20.798535	0	0	99.63
20.56	501.212	20.84249	0	3.93651	20.842491	0	0	99.93
20.6	501.212	20.89377	0	3.93651	20.893773	0	0	100.51
20.64	498.724	20.90842	0	3.91697	20.908425	0	0	99.93
20.68	499.968	20.94505	0	3.92674	20.945055	0	0	99.93
20.72	499.968	20.95971	0	3.92674	20.959707	0	0	99.63
20.76	502.455	21.00366	0	3.94628	21.003663	0	0	99.63
20.8	502.455	21.06227	0	3.94628	21.062271	0	0	99.93
20.84	499.968	21.12088	0	3.92674	21.120879	0	0	99.93
20.88	497.481	21.16484	0	3.9072	21.164835	0	0	99.93
20.92	497.481	21.20147	0	3.9072	21.201465	0	0	99.93
20.96	494.993	21.21612	0	3.88767	21.216117	0	0	99.34
21	494.993	21.2381	0	3.88767	21.238095	0	0	99.34
21.04	501.212	21.28205	0	3.93651	21.282051	0	0	100.81
21.08	501.212	21.32601	0	3.93651	21.326007	0	0	99.93
21.12	499.968	21.38462	0	3.92674	21.384615	0	0	99.93
21.16	496.237	21.44322	0	3.89744	21.443223	0	0	99.93
21.2	493.75	21.47985	0	3.8779	21.479853	0	0	99.93
21.24	492.506	21.50183	0	3.86813	21.501832	0	0	99.63
21.28	493.75	21.52381	0	3.8779	21.52381	0	0	99.93
21.32	496.237	21.56044	0	3.89744	21.56044	0	0	99.93
21.36	497.481	21.59707	0	3.9072	21.59707	0	0	99.93

21.4	497.481	21.663	0	3.9072	21.663004	0	0	99.93
21.44	494.993	21.72161	0	3.88767	21.721612	0	0	99.93
21.48	492.506	21.75824	0	3.86813	21.758242	0	0	99.63
21.52	491.262	21.78022	0	3.85836	21.78022	0	0	99.93
21.56	491.262	21.8022	0	3.85836	21.802198	0	0	99.93
21.6	494.993	21.8315	0	3.88767	21.831502	0	0	99.93
21.64	497.481	21.87546	0	3.9072	21.875458	0	0	100.22
21.68	496.237	21.94139	0	3.89744	21.941392	0	0	99.34
21.72	493.75	21.99267	0	3.8779	21.992674	0	0	99.93
21.76	490.018	22.02198	0	3.8486	22.021978	0	0	99.34
21.8	491.262	22.06593	0	3.85836	22.065934	0	0	99.93
21.84	490.018	22.08791	0	3.8486	22.087912	0	0	99.34
21.88	491.262	22.10989	0	3.85836	22.10989	0	0	99.34
21.92	493.75	22.16117	0	3.8779	22.161172	0	0	99.63
21.96	493.75	22.21978	0	3.8779	22.21978	0	0	99.93
22	491.262	22.27106	0	3.85836	22.271062	0	0	99.63
22.04	490.018	22.30769	0	3.8486	22.307692	0	0	99.93
22.08	488.775	22.337	0	3.83883	22.336996	0	0	99.93
22.12	487.531	22.3663	0	3.82906	22.3663	0	0	99.63
22.16	491.262	22.3956	0	3.85836	22.395604	0	0	99.63
22.2	491.262	22.43956	0	3.85836	22.43956	0	0	99.93
22.24	490.018	22.49084	0	3.8486	22.490842	0	0	99.34
22.28	490.018	22.54945	0	3.8486	22.549451	0	0	99.93
22.32	488.775	22.59341	0	3.83883	22.593407	0	0	99.93
22.36	487.531	22.61538	0	3.82906	22.615385	0	0	99.93
22.4	485.044	22.63004	0	3.80952	22.630037	0	0	99.34
22.44	490.018	22.67399	0	3.8486	22.673993	0	0	99.93
22.48	490.018	22.71795	0	3.8486	22.717949	0	0	99.93
22.52	490.018	22.77656	0	3.8486	22.776557	0	0	99.63
22.56	483.8	22.82051	0	3.79976	22.820513	0	0	98.75
22.6	485.044	22.87179	0	3.80952	22.871795	0	0	99.93
22.64	483.8	22.89377	0	3.79976	22.893773	0	0	99.34
22.68	483.8	22.91575	0	3.79976	22.915751	0	0	99.63
22.72	487.531	22.95238	0	3.82906	22.952381	0	0	99.93
22.76	487.531	22.99634	0	3.82906	22.996337	0	0	99.34
22.8	486.287	23.05495	0	3.81929	23.054945	0	0	99.93
22.84	483.8	23.11355	0	3.79976	23.113553	0	0	99.93
22.88	481.313	23.13553	0	3.78022	23.135531	0	0	99.34
22.92	482.556	23.16484	0	3.78999	23.164835	0	0	99.93
22.96	483.8	23.19414	0	3.79976	23.194139	0	0	99.93
23	486.287	23.2381	0	3.81929	23.238095	0	0	99.93

Stabilised red sand: confining pressure 150 kPa

IPC Global Universal Testing Machine
UTM_12 V2.00 Stress - Strain Test

Filename	D:\my research\Lab test Data\Triaxial\RSFALKD\UU-test\RSFALKD-triaxial-150kPa.B12							
Operator	Mr.Peerapong Jitsangiam							
Test type	Compression test							
Notes/Comments		RSFALKD						
Specimen shape	Cylindrical							
Specimen Information								
********************								
Identification	RSFALKD							
Core/Sample Number								
Dimensions	Point 1	Point 2	Point 3	Point 4	Point 5	Point 6	Average	Std Dev.
Diameter (mm)	100						100	
Height (mm)	100						100	
Cross-Sectional area	7853.982							
Volume	785398.2							
Comments/Properties								
Setup Parameters								
****************								
Pre-load stress (kPa)								
Pre-load load (kN)								
Pre-load hold time (s)								
Confining pressure (kPa)	150							
Confining hold time (s)	5							
Dump pressure at end of test	Yes							
Axial gauge length (mm)	100							
Radial gauge length (mm)								
Advanced loading control	Disabled							
Control Mode	Displacement (actuator)							
Loading Rate (mm/s)	1							
Termination Timer (sec)	0							
% Unload	0							
Minimum stress (kPa)	0							
Minimum load (kN)	0							
Termination Actuator (mm)	0							
Termination Axial (mm)	250							
Termination Radial (mm)	0							
Calibration Information								
***********************								
Channel description	Filename	Transducer description	Span	Units	Date	Linearised		
A: Axial Force	Y12346.CAR	STC5000 S/N: Y12346 +/-20kN	40	kN	7/12/2005	No		
B: Actuator LVDT	941C-340.CAR	AC-15 S/N: M992941C-340 +/-15mm	30	mm	7/12/2005	No		
C: Axial LVDT #1	83047.car	D6-05000A S/N: 83047 +/-5mm	10	mm	20/12/2005	Yes		
D: Axial LVDT #2	83048.car	D6-05000A S/N: 83048 +/-5mm	10	mm	20/12/2005	Yes		
E: Radial LVDT #1	S054041.CAR	IT2000AG S/N: S054041 +/-600kPa	1200	kPa	22/01/2004	No		
F: Radial LVDT #2		Undefined/Not Used	1	?		No		
G: Temperature Probe		Undefined/Not Used	1	?		No		
H: Confining Pressure	S054041.CAR	IT2000AG S/N: S054041 +/-600kPa	1200	kPa	22/01/2004	No		
Test Results								
************								
Start date and time	Wednesday	December 20	2006	at 12:38 PM				
Timer (sec)	35							
Peak compressive stress (kPa)	909.1							
Peak load (kN)	7.14							
Actuator strain at peak load (%)	8.366							
Actuator deformation at peak load (mm)	8.366							
Axial av. strain at peak load (%)	0							
Axial av. deform. at peak load (mm)	0							
Time	Stress	Actuator Strain	Axial average strain	Load	Actuator	Axial LVDT #1	Axial LVDT #2	Confining Pressure
(sec)	(kPa)	(%)	(%)	(kN)	(mm)	(mm)	(mm)	(kPa)
0	1.244	0	0	0.00977	0	0	0	149.45
0.04	8.706	0.40293	0	0.06838	0.40293	0	0	149.74
0.08	8.706	0.43956	0	0.06838	0.43956	0	0	149.74
0.12	8.706	0.47619	0	0.06838	0.47619	0	0	149.74
0.16	8.706	0.52747	0	0.06838	0.527473	0	0	150.04
0.2	9.95	0.5641	0	0.07814	0.564103	0	0	150.04
0.24	8.706	0.60806	0	0.06838	0.608059	0	0	149.74
0.28	8.706	0.64469	0	0.06838	0.644689	0	0	149.74

0.32	8.706	0.68132	0	0.06838	0.681319	0	0	149.74
0.36	9.95	0.72527	0	0.07814	0.725275	0	0	149.74
0.4	8.706	0.7619	0	0.06838	0.761905	0	0	149.74
0.44	8.706	0.79853	0	0.06838	0.798535	0	0	149.74
0.48	8.706	0.84249	0	0.06838	0.842491	0	0	149.74
0.52	8.706	0.88645	0	0.06838	0.886447	0	0	149.74
0.56	8.706	0.91575	0	0.06838	0.915751	0	0	149.45
0.6	6.219	0.94505	0	0.04884	0.945055	0	0	149.16
0.64	8.706	1.00366	0	0.06838	1.003663	0	0	150.04
0.68	8.706	1.04029	0	0.06838	1.040293	0	0	150.04
0.72	8.706	1.07692	0	0.06838	1.076923	0	0	149.74
0.76	4.975	1.0989	0	0.03907	1.098901	0	0	148.86
0.8	7.462	1.15751	0	0.05861	1.157509	0	0	149.74
0.84	8.706	1.20147	0	0.06838	1.201465	0	0	149.74
0.88	8.706	1.2381	0	0.06838	1.238095	0	0	149.74
0.92	8.706	1.28205	0	0.06838	1.282051	0	0	150.04
0.96	8.706	1.31868	0	0.06838	1.318681	0	0	149.74
1	8.706	1.35531	0	0.06838	1.355311	0	0	149.74
1.04	11.193	1.40659	0	0.08791	1.406593	0	0	150.33
1.08	8.706	1.4359	0	0.06838	1.435897	0	0	149.74
1.12	8.706	1.47985	0	0.06838	1.479853	0	0	149.74
1.16	8.706	1.51648	0	0.06838	1.516484	0	0	149.74
1.2	8.706	1.56044	0	0.06838	1.56044	0	0	149.45
1.24	8.706	1.59707	0	0.06838	1.59707	0	0	149.74
1.28	8.706	1.6337	0	0.06838	1.6337	0	0	149.74
1.32	11.193	1.68498	0	0.08791	1.684982	0	0	150.33
1.36	7.462	1.71429	0	0.05861	1.714286	0	0	149.74
1.4	8.706	1.75824	0	0.06838	1.758242	0	0	149.74
1.44	8.706	1.79487	0	0.06838	1.794872	0	0	149.74
1.48	9.95	1.83883	0	0.07814	1.838828	0	0	150.04
1.52	8.706	1.86813	0	0.06838	1.868132	0	0	150.04
1.56	8.706	1.91209	0	0.06838	1.912088	0	0	149.74
1.6	8.706	1.95604	0	0.06838	1.956044	0	0	149.74
1.64	7.462	1.99267	0	0.05861	1.992674	0	0	149.74
1.68	8.706	2.03663	0	0.06838	2.03663	0	0	149.74
1.72	8.706	2.07326	0	0.06838	2.07326	0	0	149.74
1.76	9.95	2.11722	0	0.07814	2.117216	0	0	150.04
1.8	8.706	2.15385	0	0.06838	2.153846	0	0	149.74
1.84	8.706	2.19048	0	0.06838	2.190476	0	0	149.74
1.88	12.437	2.25641	0	0.09768	2.25641	0	0	150.92
1.92	9.95	2.27839	0	0.07814	2.278388	0	0	150.33
1.96	9.95	2.31502	0	0.07814	2.315018	0	0	150.04
2	13.681	2.337	0	0.10745	2.336996	0	0	149.74
2.04	22.387	2.3663	0	0.17582	2.3663	0	0	149.74
2.08	32.336	2.40293	0	0.25397	2.40293	0	0	150.04
2.12	43.53	2.43956	0	0.34188	2.43956	0	0	150.04
2.16	53.479	2.49084	0	0.42002	2.490842	0	0	149.74
2.2	67.16	2.52015	0	0.52747	2.520147	0	0	149.74
2.24	83.328	2.5641	0	0.65446	2.564103	0	0	150.04
2.28	98.252	2.60073	0	0.77167	2.600733	0	0	149.74
2.32	116.908	2.65201	0	0.91819	2.652015	0	0	150.33
2.36	130.589	2.68864	0	1.02564	2.688645	0	0	149.74
2.4	146.757	2.7326	0	1.15263	2.732601	0	0	149.74
2.44	161.681	2.77656	0	1.26984	2.776557	0	0	149.74
2.48	174.118	2.80586	0	1.36752	2.805861	0	0	149.16
2.52	191.53	2.86447	0	1.50427	2.864469	0	0	149.74
2.56	206.454	2.90842	0	1.62149	2.908425	0	0	149.74
2.6	220.135	2.95238	0	1.72894	2.952381	0	0	149.74
2.64	232.572	2.98168	0	1.82662	2.981685	0	0	149.45
2.68	248.74	3.03297	0	1.9536	3.032967	0	0	150.33
2.72	258.69	3.0696	0	2.03175	3.069597	0	0	149.74
2.76	272.371	3.10623	0	2.13919	3.106227	0	0	149.74
2.8	284.808	3.13553	0	2.23687	3.135531	0	0	149.16
2.84	300.976	3.18681	0	2.36386	3.186813	0	0	149.74
2.88	314.657	3.23077	0	2.47131	3.230769	0	0	149.74
2.92	327.094	3.26007	0	2.56899	3.260073	0	0	149.16
2.96	343.262	3.31868	0	2.69597	3.318681	0	0	150.62
3	351.968	3.34066	0	2.76435	3.340659	0	0	149.74
3.04	366.892	3.38462	0	2.88156	3.384615	0	0	149.74
3.08	380.573	3.42857	0	2.98901	3.428571	0	0	149.74
3.12	390.522	3.45055	0	3.06716	3.450549	0	0	149.16
3.16	405.447	3.50916	0	3.18437	3.509158	0	0	149.74
3.2	416.64	3.54579	0	3.27228	3.545788	0	0	149.45
3.24	427.833	3.58242	0	3.3602	3.582418	0	0	149.74
3.28	439.027	3.61905	0	3.44811	3.619048	0	0	149.45
3.32	452.707	3.663	0	3.55556	3.663004	0	0	149.74
3.36	463.901	3.70696	0	3.64347	3.70696	0	0	150.04
3.4	475.094	3.75092	0	3.73138	3.750916	0	0	150.04
3.44	486.287	3.78755	0	3.81929	3.787546	0	0	150.04
3.48	494.993	3.8315	0	3.88767	3.831502	0	0	149.74
3.52	506.187	3.86813	0	3.97558	3.868132	0	0	149.74
3.56	516.136	3.90476	0	4.05372	3.904762	0	0	149.74
3.6	526.086	3.94872	0	4.13187	3.948718	0	0	149.74
3.64	534.792	3.98535	0	4.20024	3.985348	0	0	149.74
3.68	544.741	4.0293	0	4.27839	4.029304	0	0	150.04
3.72	553.447	4.06593	0	4.34676	4.065934	0	0	150.04
3.76	560.909	4.09524	0	4.40537	4.095238	0	0	149.74
3.8	568.372	4.13919	0	4.46398	4.139194	0	0	149.45

3.84	578.321	4.18315	0	4.54212	4.18315	0	0	149.74
3.88	588.271	4.24176	0	4.62027	4.241758	0	0	150.33
3.92	594.489	4.26374	0	4.66911	4.263736	0	0	149.74
3.96	600.708	4.30037	0	4.71795	4.300366	0	0	149.74
4	609.414	4.35897	0	4.78632	4.358974	0	0	150.33
4.04	616.876	4.38095	0	4.84493	4.380952	0	0	150.04
4.08	621.851	4.41758	0	4.884	4.417582	0	0	149.45
4.12	629.313	4.46886	0	4.94261	4.468864	0	0	149.74
4.16	635.532	4.49817	0	4.99145	4.498168	0	0	149.45
4.2	641.75	4.54212	0	5.04029	4.542125	0	0	149.74
4.24	647.969	4.58608	0	5.08913	4.586081	0	0	149.74
4.28	650.456	4.60073	0	5.10867	4.600733	0	0	148.86
4.32	659.162	4.65201	0	5.17705	4.652015	0	0	149.16
4.36	666.624	4.7033	0	5.23565	4.703297	0	0	149.74
4.4	671.599	4.73993	0	5.27473	4.739927	0	0	149.74
4.44	670.355	4.74725	0	5.26496	4.747253	0	0	148.28
4.48	682.792	4.82784	0	5.36264	4.827839	0	0	150.33
4.52	686.523	4.85714	0	5.39194	4.857143	0	0	149.74
4.56	695.229	4.90842	0	5.46032	4.908425	0	0	150.33
4.6	702.691	4.96703	0	5.51893	4.967033	0	0	150.92
4.64	703.935	4.98168	0	5.52869	4.981685	0	0	149.74
4.68	707.666	5.01832	0	5.558	5.018315	0	0	149.74
4.72	711.397	5.06227	0	5.5873	5.062271	0	0	149.74
4.76	716.372	5.09158	0	5.62637	5.091575	0	0	149.74
4.8	722.591	5.13553	0	5.67521	5.135531	0	0	149.74
4.84	727.565	5.17949	0	5.71429	5.179487	0	0	149.74
4.88	732.54	5.22344	0	5.75336	5.223443	0	0	149.74
4.92	735.028	5.2674	0	5.77289	5.267399	0	0	149.74
4.96	738.759	5.2967	0	5.8022	5.296703	0	0	149.45
5	743.734	5.33333	0	5.84127	5.333333	0	0	149.74
5.04	748.708	5.38462	0	5.88034	5.384615	0	0	150.04
5.08	753.683	5.41392	0	5.91941	5.413919	0	0	149.74
5.12	759.902	5.45788	0	5.96825	5.457875	0	0	150.04
5.16	763.633	5.50183	0	5.99756	5.501832	0	0	149.74
5.2	767.364	5.53846	0	6.02686	5.538462	0	0	149.45
5.24	769.851	5.58242	0	6.0464	5.582418	0	0	149.74
5.28	772.339	5.61905	0	6.06593	5.619048	0	0	149.74
5.32	777.314	5.64835	0	6.10501	5.648352	0	0	149.74
5.36	782.288	5.69231	0	6.14408	5.692308	0	0	149.74
5.4	787.263	5.72894	0	6.18315	5.728938	0	0	149.74
5.44	792.238	5.78022	0	6.22222	5.78022	0	0	149.74
5.48	795.969	5.82418	0	6.25153	5.824176	0	0	149.74
5.52	799.7	5.86813	0	6.28083	5.868132	0	0	149.74
5.56	800.944	5.90476	0	6.2906	5.904762	0	0	150.04
5.6	804.675	5.94139	0	6.3199	5.941392	0	0	150.33
5.64	805.919	5.9707	0	6.32967	5.970696	0	0	149.74
5.68	810.893	6.00733	0	6.36874	6.007326	0	0	149.74
5.72	814.625	6.03663	0	6.39805	6.03663	0	0	149.16
5.76	820.843	6.08059	0	6.44689	6.080586	0	0	149.45
5.8	825.818	6.13919	0	6.48596	6.139194	0	0	149.45
5.84	827.062	6.17582	0	6.49573	6.175824	0	0	149.74
5.88	829.549	6.22711	0	6.51526	6.227106	0	0	149.74
5.92	833.28	6.27839	0	6.54457	6.278388	0	0	150.33
5.96	832.036	6.29304	0	6.5348	6.29304	0	0	149.74
6	835.767	6.32967	0	6.5641	6.32967	0	0	149.74
6.04	839.499	6.35897	0	6.59341	6.358974	0	0	149.74
6.08	845.717	6.40293	0	6.64225	6.40293	0	0	149.74
6.12	849.448	6.44689	0	6.67155	6.446886	0	0	149.74
6.16	853.179	6.49817	0	6.70085	6.498168	0	0	149.74
6.2	854.423	6.54212	0	6.71062	6.542125	0	0	149.45
6.24	855.667	6.58608	0	6.72039	6.586081	0	0	149.74
6.28	856.91	6.62271	0	6.73016	6.622711	0	0	150.04
6.32	861.885	6.67399	0	6.76923	6.673993	0	0	150.62
6.36	859.398	6.68864	0	6.74969	6.688645	0	0	149.45
6.4	864.373	6.71795	0	6.78877	6.717949	0	0	149.74
6.44	868.104	6.76923	0	6.81807	6.769231	0	0	149.74
6.48	875.566	6.83516	0	6.87668	6.835165	0	0	150.62
6.52	875.566	6.86447	0	6.87668	6.864469	0	0	150.04
6.56	876.81	6.90842	0	6.88645	6.908425	0	0	149.74
6.6	875.566	6.93773	0	6.87668	6.937729	0	0	149.74
6.64	875.566	6.98168	0	6.87668	6.981685	0	0	149.74
6.68	875.566	7.01099	0	6.87668	7.010989	0	0	149.74
6.72	878.053	7.04029	0	6.89621	7.040293	0	0	149.45
6.76	881.784	7.08425	0	6.92552	7.084249	0	0	149.74
6.8	888.003	7.13553	0	6.97436	7.135531	0	0	150.33
6.84	889.247	7.16484	0	6.98413	7.164835	0	0	149.74
6.88	891.734	7.21612	0	7.00366	7.216117	0	0	149.74
6.92	892.978	7.26007	0	7.01343	7.260073	0	0	149.74
6.96	892.978	7.31868	0	7.01343	7.318681	0	0	150.33
7	890.49	7.34066	0	6.99389	7.340659	0	0	149.74
7.04	890.49	7.37729	0	6.99389	7.377289	0	0	149.74
7.08	890.49	7.40659	0	6.99389	7.406593	0	0	149.74
7.12	891.734	7.42857	0	7.00366	7.428571	0	0	149.16
7.16	896.709	7.47985	0	7.04274	7.479853	0	0	149.74
7.2	900.44	7.52381	0	7.07204	7.52381	0	0	149.74
7.24	901.684	7.57509	0	7.08181	7.575092	0	0	149.74
7.28	901.684	7.61905	0	7.08181	7.619048	0	0	149.74
7.32	900.44	7.67033	0	7.07204	7.67033	0	0	150.33

7.36	897.953	7.69963	0	7.0525	7.699634	0	0	149.74
7.4	896.709	7.72894	0	7.04274	7.728938	0	0	149.74
7.44	896.709	7.75824	0	7.04274	7.758242	0	0	149.45
7.48	899.196	7.8022	0	7.06227	7.802198	0	0	149.74
7.52	902.927	7.83883	0	7.09158	7.838828	0	0	150.04
7.56	906.658	7.88278	0	7.12088	7.882784	0	0	149.74
7.6	907.902	7.93407	0	7.13065	7.934066	0	0	150.33
7.64	906.658	7.97802	0	7.12088	7.978022	0	0	149.74
7.68	905.415	8.02198	0	7.11111	8.021978	0	0	149.74
7.72	901.684	8.06593	0	7.08181	8.065934	0	0	149.74
7.76	901.684	8.10989	0	7.08181	8.10989	0	0	150.33
7.8	899.196	8.13187	0	7.06227	8.131868	0	0	149.45
7.84	899.196	8.16117	0	7.06227	8.161172	0	0	149.74
7.88	901.684	8.1978	0	7.08181	8.197802	0	0	149.74
7.92	904.171	8.22711	0	7.10134	8.227106	0	0	149.74
7.96	907.902	8.27839	0	7.13065	8.278388	0	0	149.74
8	906.658	8.32967	0	7.12088	8.32967	0	0	149.74
8.04	902.927	8.37363	0	7.09158	8.373626	0	0	149.45
8.08	901.684	8.43223	0	7.08181	8.432234	0	0	150.33
8.12	899.196	8.46886	0	7.06227	8.468864	0	0	149.74
8.16	899.196	8.51282	0	7.06227	8.512821	0	0	150.33
8.2	892.978	8.52015	0	7.01343	8.520147	0	0	149.16
8.24	895.465	8.55678	0	7.03297	8.556777	0	0	149.74
8.28	896.709	8.59341	0	7.04274	8.593407	0	0	149.45
8.32	905.415	8.65934	0	7.11111	8.659341	0	0	151.21
8.36	901.684	8.67399	0	7.08181	8.673993	0	0	149.74
8.4	901.684	8.7326	0	7.08181	8.732601	0	0	150.04
8.44	897.953	8.78388	0	7.0525	8.783883	0	0	149.74
8.48	894.221	8.82784	0	7.0232	8.827839	0	0	149.74
8.52	890.49	8.85714	0	6.99389	8.857143	0	0	149.74
8.56	888.003	8.89377	0	6.97436	8.893773	0	0	149.74
8.6	886.759	8.92308	0	6.96459	8.923077	0	0	149.74
8.64	886.759	8.94505	0	6.96459	8.945055	0	0	149.45
8.68	889.247	8.98901	0	6.98413	8.989011	0	0	149.74
8.72	891.734	9.02564	0	7.00366	9.025641	0	0	149.74
8.76	894.221	9.07692	0	7.0232	9.076923	0	0	149.74
8.8	891.734	9.12821	0	7.00366	9.128205	0	0	149.74
8.84	888.003	9.17949	0	6.97436	9.179487	0	0	149.74
8.88	884.272	9.22344	0	6.94505	9.223443	0	0	149.74
8.92	880.541	9.26007	0	6.91575	9.260073	0	0	149.74
8.96	878.053	9.28938	0	6.89621	9.289377	0	0	149.74
9	876.81	9.31868	0	6.88645	9.318681	0	0	149.74
9.04	876.81	9.34799	0	6.88645	9.347985	0	0	149.74
9.08	876.81	9.36996	0	6.88645	9.369963	0	0	149.16
9.12	883.028	9.4359	0	6.93529	9.435897	0	0	150.33
9.16	879.297	9.45788	0	6.90598	9.457875	0	0	149.16
9.2	880.541	9.53114	0	6.91575	9.531136	0	0	149.74
9.24	875.566	9.57509	0	6.87668	9.575092	0	0	149.45
9.28	871.835	9.62637	0	6.84737	9.626374	0	0	149.74
9.32	868.104	9.663	0	6.81807	9.663004	0	0	149.74
9.36	865.616	9.69231	0	6.79853	9.692308	0	0	149.45
9.4	865.616	9.72894	0	6.79853	9.728938	0	0	150.04
9.44	863.129	9.74359	0	6.779	9.74359	0	0	149.16
9.48	866.86	9.78022	0	6.8083	9.78022	0	0	149.45
9.52	871.835	9.83883	0	6.84737	9.838828	0	0	150.92
9.56	870.591	9.86813	0	6.83761	9.868132	0	0	150.04
9.6	869.347	9.91941	0	6.82784	9.919414	0	0	149.74
9.64	865.616	9.97802	0	6.79853	9.978022	0	0	149.74
9.68	859.398	10.01465	0	6.74969	10.014652	0	0	149.45
9.72	854.423	10.05128	0	6.71062	10.051282	0	0	149.16
9.76	854.423	10.09524	0	6.71062	10.095238	0	0	150.33
9.8	851.936	10.11722	0	6.69109	10.117216	0	0	149.74
9.84	848.205	10.13187	0	6.66178	10.131868	0	0	149.16
9.88	853.179	10.17582	0	6.70085	10.175824	0	0	149.74
9.92	855.667	10.21245	0	6.72039	10.212454	0	0	149.74
9.96	858.154	10.26374	0	6.73993	10.263736	0	0	150.04
10	859.398	10.32967	0	6.74969	10.32967	0	0	150.33
10.04	853.179	10.37363	0	6.70085	10.373626	0	0	149.74
10.08	848.205	10.42491	0	6.66178	10.424908	0	0	149.74
10.12	844.473	10.46154	0	6.63248	10.461538	0	0	149.74
10.16	839.499	10.49084	0	6.59341	10.490842	0	0	149.45
10.2	838.255	10.52747	0	6.58364	10.527473	0	0	149.74
10.24	837.011	10.54945	0	6.57387	10.549451	0	0	149.74
10.28	839.499	10.57875	0	6.59341	10.578755	0	0	149.74
10.32	841.986	10.61538	0	6.61294	10.615385	0	0	149.74
10.36	844.473	10.65934	0	6.63248	10.659341	0	0	150.04
10.4	844.473	10.71062	0	6.63248	10.710623	0	0	149.74
10.44	838.255	10.75458	0	6.58364	10.754579	0	0	148.57
10.48	837.011	10.82784	0	6.57387	10.827839	0	0	149.74
10.52	832.036	10.87179	0	6.5348	10.871795	0	0	149.74
10.56	825.818	10.89377	0	6.48596	10.893773	0	0	149.16
10.6	825.818	10.9304	0	6.48596	10.930403	0	0	149.74
10.64	823.33	10.95238	0	6.46642	10.952381	0	0	149.74
10.68	824.574	10.98168	0	6.47619	10.981685	0	0	149.74
10.72	828.305	11.01832	0	6.50549	11.018315	0	0	150.33
10.76	829.549	11.05495	0	6.51526	11.054945	0	0	149.74
10.8	829.549	11.10623	0	6.51526	11.106227	0	0	149.74
10.84	828.305	11.16484	0	6.50549	11.164835	0	0	150.33

10.88	822.087	11.20879	0	6.45665	11.208791	0	0	149.45
10.92	818.356	11.26007	0	6.42735	11.260073	0	0	149.74
10.96	814.625	11.2967	0	6.39805	11.296703	0	0	149.45
11	809.65	11.31136	0	6.35897	11.311355	0	0	149.16
11.04	809.65	11.35531	0	6.35897	11.355311	0	0	149.74
11.08	809.65	11.37729	0	6.35897	11.377289	0	0	149.74
11.12	812.137	11.40659	0	6.37851	11.406593	0	0	149.74
11.16	813.381	11.45055	0	6.38828	11.450549	0	0	149.74
11.2	815.868	11.50183	0	6.40781	11.501832	0	0	149.45
11.24	814.625	11.56777	0	6.39805	11.567766	0	0	150.04
11.28	809.65	11.61172	0	6.35897	11.611722	0	0	149.74
11.32	805.919	11.65568	0	6.32967	11.655678	0	0	149.74
11.36	800.944	11.69231	0	6.2906	11.692308	0	0	149.45
11.4	792.238	11.69963	0	6.22222	11.699634	0	0	148.28
11.44	792.238	11.72894	0	6.22222	11.728938	0	0	148.86
11.48	794.725	11.78022	0	6.24176	11.78022	0	0	149.74
11.52	797.213	11.8022	0	6.26129	11.802198	0	0	149.74
11.56	799.7	11.84615	0	6.28083	11.846154	0	0	149.74
11.6	802.188	11.89744	0	6.30037	11.897436	0	0	149.74
11.64	800.944	11.94872	0	6.2906	11.948718	0	0	150.04
11.68	797.213	12.01465	0	6.26129	12.014652	0	0	150.04
11.72	792.238	12.05861	0	6.22222	12.058608	0	0	149.74
11.76	788.507	12.09524	0	6.19292	12.095238	0	0	150.04
11.8	784.776	12.13187	0	6.16361	12.131868	0	0	149.74
11.84	783.532	12.1685	0	6.15385	12.168498	0	0	150.04
11.88	779.801	12.17582	0	6.12454	12.175824	0	0	149.74
11.92	782.288	12.20513	0	6.14408	12.205128	0	0	149.74
11.96	784.776	12.24176	0	6.16361	12.241758	0	0	149.74
12	786.019	12.28571	0	6.17338	12.285714	0	0	149.74
12.04	787.263	12.34432	0	6.18315	12.344322	0	0	150.04
12.08	783.532	12.40293	0	6.15385	12.40293	0	0	149.74
12.12	778.557	12.43956	0	6.11477	12.43956	0	0	149.16
12.16	776.07	12.49084	0	6.09524	12.490842	0	0	149.74
12.2	772.339	12.52747	0	6.06593	12.527473	0	0	149.74
12.24	769.851	12.55678	0	6.0464	12.556777	0	0	149.45
12.28	768.608	12.58608	0	6.03663	12.586081	0	0	149.74
12.32	769.851	12.60806	0	6.0464	12.608059	0	0	149.74
12.36	771.095	12.64469	0	6.05617	12.644689	0	0	149.45
12.4	774.826	12.69597	0	6.08547	12.695971	0	0	150.33
12.44	773.582	12.74725	0	6.0757	12.747253	0	0	150.04
12.48	771.095	12.79853	0	6.05617	12.798535	0	0	149.74
12.52	767.364	12.84982	0	6.02686	12.849817	0	0	149.74
12.56	762.389	12.88645	0	5.98779	12.886447	0	0	149.74
12.6	759.902	12.9304	0	5.96825	12.930403	0	0	150.04
12.64	757.414	12.95238	0	5.94872	12.952381	0	0	149.74
12.68	756.171	12.98168	0	5.93895	12.981685	0	0	149.45
12.72	756.171	13.01099	0	5.93895	13.010989	0	0	149.45
12.76	759.902	13.04762	0	5.96825	13.047619	0	0	149.74
12.8	761.145	13.08425	0	5.97802	13.084249	0	0	149.74
12.84	759.902	13.13553	0	5.96825	13.135531	0	0	149.74
12.88	758.658	13.19414	0	5.95849	13.194139	0	0	149.74
12.92	758.658	13.2674	0	5.95849	13.267399	0	0	150.92
12.96	749.952	13.28205	0	5.89011	13.282051	0	0	149.74
13	746.221	13.32601	0	5.86081	13.326007	0	0	149.74
13.04	744.977	13.34799	0	5.85104	13.347985	0	0	149.74
13.08	743.734	13.36996	0	5.84127	13.369963	0	0	149.74
13.12	743.734	13.39927	0	5.84127	13.399267	0	0	149.74
13.16	747.465	13.44322	0	5.87057	13.443223	0	0	149.74
13.2	751.196	13.49451	0	5.89988	13.494505	0	0	150.62
13.24	748.708	13.53846	0	5.88034	13.538462	0	0	149.74
13.28	746.221	13.59707	0	5.86081	13.59707	0	0	149.74
13.32	746.221	13.67033	0	5.86081	13.67033	0	0	150.92
13.36	740.002	13.69231	0	5.81197	13.692308	0	0	150.33
13.4	735.028	13.71429	0	5.77289	13.714286	0	0	149.74
13.44	732.54	13.74359	0	5.75336	13.74359	0	0	149.74
13.48	733.784	13.77289	0	5.76313	13.772894	0	0	150.33
13.52	732.54	13.8022	0	5.75336	13.802198	0	0	149.74
13.56	735.028	13.83883	0	5.77289	13.838828	0	0	149.45
13.6	737.515	13.88278	0	5.79243	13.882784	0	0	149.74
13.64	736.271	13.93407	0	5.78266	13.934066	0	0	149.45
13.68	733.784	13.99267	0	5.76313	13.992674	0	0	149.74
13.72	731.297	14.04396	0	5.74359	14.043956	0	0	150.04
13.76	727.565	14.08059	0	5.71429	14.080586	0	0	149.74
13.8	723.834	14.10989	0	5.68498	14.10989	0	0	149.74
13.84	722.591	14.13919	0	5.67521	14.139194	0	0	149.74
13.88	722.591	14.1685	0	5.67521	14.168498	0	0	149.74
13.92	723.834	14.19048	0	5.68498	14.190476	0	0	149.45
13.96	726.322	14.23443	0	5.70452	14.234432	0	0	149.74
14	727.565	14.28571	0	5.71429	14.285714	0	0	149.74
14.04	726.322	14.35165	0	5.70452	14.351648	0	0	150.04
14.08	722.591	14.3956	0	5.67521	14.395604	0	0	149.74
14.12	717.616	14.43956	0	5.63614	14.43956	0	0	149.45
14.16	715.128	14.47619	0	5.61661	14.47619	0	0	150.04
14.2	712.641	14.49817	0	5.59707	14.498168	0	0	149.74
14.24	712.641	14.5348	0	5.59707	14.534799	0	0	149.74
14.28	712.641	14.55678	0	5.59707	14.556777	0	0	149.74
14.32	716.372	14.60073	0	5.62637	14.600733	0	0	149.74
14.36	717.616	14.64469	0	5.63614	14.644689	0	0	150.04

14.4	716.372	14.69597	0	5.62637	14.695971	0	0	149.74
14.44	713.885	14.74725	0	5.60684	14.747253	0	0	149.74
14.48	710.154	14.79853	0	5.57753	14.798535	0	0	149.45
14.52	706.423	14.82784	0	5.54823	14.827839	0	0	149.74
14.56	703.935	14.86447	0	5.52869	14.864469	0	0	149.74
14.6	702.691	14.88645	0	5.51893	14.886447	0	0	149.74
14.64	701.448	14.90842	0	5.50916	14.908425	0	0	149.74
14.68	705.179	14.95238	0	5.53846	14.952381	0	0	149.74
14.72	707.666	15.00366	0	5.558	15.003663	0	0	150.33
14.76	707.666	15.04762	0	5.558	15.047619	0	0	149.74
14.8	705.179	15.10623	0	5.53846	15.106227	0	0	149.74
14.84	700.204	15.15018	0	5.49939	15.150183	0	0	149.74
14.88	697.717	15.20147	0	5.47985	15.201465	0	0	150.04
14.92	693.986	15.22344	0	5.45055	15.223443	0	0	149.74
14.96	692.742	15.25275	0	5.44078	15.252747	0	0	149.74
15	691.498	15.2674	0	5.43101	15.267399	0	0	149.45
15.04	695.229	15.31136	0	5.46032	15.311355	0	0	149.74
15.08	697.717	15.35531	0	5.47985	15.355311	0	0	149.74
15.12	696.473	15.39927	0	5.47009	15.399267	0	0	149.45
15.16	695.229	15.4652	0	5.46032	15.465201	0	0	149.74
15.2	691.498	15.50183	0	5.43101	15.501832	0	0	149.45
15.24	687.767	15.55311	0	5.40171	15.553114	0	0	149.74
15.28	686.523	15.58242	0	5.39194	15.582418	0	0	149.74
15.32	682.792	15.61172	0	5.36264	15.611722	0	0	149.74
15.36	681.548	15.6337	0	5.35287	15.6337	0	0	149.45
15.4	684.036	15.67033	0	5.37241	15.67033	0	0	149.74
15.44	687.767	15.70696	0	5.40171	15.70696	0	0	149.74
15.48	687.767	15.76557	0	5.40171	15.765568	0	0	150.33
15.52	698.96	15.88278	0	5.48962	15.882784	0	0	153.26
15.56	684.036	15.86813	0	5.37241	15.868132	0	0	150.04
15.6	680.305	15.91209	0	5.3431	15.912088	0	0	149.74
15.64	676.574	15.94872	0	5.3138	15.948718	0	0	149.74
15.68	674.086	15.9707	0	5.29426	15.970696	0	0	149.74
15.72	674.086	16	0	5.29426	16	0	0	149.74
15.76	675.33	16.0293	0	5.30403	16.029304	0	0	149.74
15.8	677.817	16.06593	0	5.32357	16.065934	0	0	149.74
15.84	680.305	16.11722	0	5.3431	16.117216	0	0	150.04
15.88	677.817	16.1685	0	5.32357	16.168498	0	0	149.74
15.92	676.574	16.22711	0	5.3138	16.227106	0	0	150.04
15.96	671.599	16.27106	0	5.27473	16.271062	0	0	149.45
16	667.868	16.30769	0	5.24542	16.307692	0	0	149.74
16.04	665.38	16.32967	0	5.22589	16.32967	0	0	149.45
16.08	664.137	16.35897	0	5.21612	16.358974	0	0	149.74
16.12	665.38	16.38828	0	5.22589	16.388278	0	0	149.74
16.16	666.624	16.41758	0	5.23565	16.417582	0	0	149.74
16.2	669.111	16.46886	0	5.25519	16.468864	0	0	149.74
16.24	669.111	16.52015	0	5.25519	16.520147	0	0	149.74
16.28	666.624	16.58608	0	5.23565	16.586081	0	0	149.74
16.32	661.649	16.63004	0	5.19658	16.630037	0	0	149.74
16.36	657.918	16.66667	0	5.16728	16.666667	0	0	149.74
16.4	652.943	16.68132	0	5.12821	16.681319	0	0	148.86
16.44	655.431	16.72527	0	5.14774	16.725275	0	0	149.74
16.48	655.431	16.75458	0	5.14774	16.754579	0	0	149.74
16.52	656.674	16.78388	0	5.15751	16.783883	0	0	149.74
16.56	659.162	16.82784	0	5.17705	16.827839	0	0	149.74
16.6	659.162	16.87912	0	5.17705	16.879121	0	0	149.74
16.64	657.918	16.95238	0	5.16728	16.952381	0	0	150.33
16.68	654.187	16.98901	0	5.13797	16.989011	0	0	150.33
16.72	649.212	17.01832	0	5.0989	17.018315	0	0	149.74
16.76	646.725	17.04762	0	5.07937	17.047619	0	0	149.74
16.8	644.237	17.0696	0	5.05983	17.069597	0	0	149.45
16.84	642.994	17.09158	0	5.05006	17.091575	0	0	149.16
16.88	649.212	17.15018	0	5.0989	17.150183	0	0	150.33
16.92	650.456	17.19414	0	5.10867	17.194139	0	0	150.04
16.96	647.969	17.2381	0	5.08913	17.238095	0	0	149.74
17	646.725	17.2967	0	5.07937	17.296703	0	0	150.04
17.04	642.994	17.34799	0	5.05006	17.347985	0	0	150.33
17.08	639.263	17.37729	0	5.02076	17.377289	0	0	149.74
17.12	635.532	17.39927	0	4.99145	17.399267	0	0	149.16
17.16	635.532	17.4359	0	4.99145	17.435897	0	0	149.74
17.2	636.775	17.45788	0	5.00122	17.457875	0	0	149.74
17.24	638.019	17.49451	0	5.01099	17.494505	0	0	149.74
17.28	641.75	17.54579	0	5.04029	17.545788	0	0	149.74
17.32	640.506	17.6044	0	5.03053	17.604396	0	0	149.74
17.36	636.775	17.663	0	5.00122	17.663004	0	0	149.74
17.4	633.044	17.70696	0	4.97192	17.70696	0	0	149.74
17.44	630.557	17.74359	0	4.95238	17.74359	0	0	150.04
17.48	629.313	17.77289	0	4.94261	17.772894	0	0	150.33
17.52	628.069	17.78755	0	4.93284	17.787546	0	0	149.74
17.56	629.313	17.82418	0	4.94261	17.824176	0	0	150.04
17.6	630.557	17.85348	0	4.95238	17.85348	0	0	149.74
17.64	631.8	17.91209	0	4.96215	17.912088	0	0	149.74
17.68	629.313	17.96337	0	4.94261	17.96337	0	0	149.74
17.72	626.826	18.01465	0	4.92308	18.014652	0	0	149.74
17.76	625.582	18.06593	0	4.91331	18.065934	0	0	150.33
17.8	620.607	18.08791	0	4.87424	18.087912	0	0	149.74
17.84	620.607	18.11722	0	4.87424	18.117216	0	0	149.74
17.88	620.607	18.14652	0	4.87424	18.14652	0	0	149.74

17.92	620.607	18.17582	0	4.87424	18.175824	0	0	149.45
17.96	624.338	18.21978	0	4.90354	18.21978	0	0	150.04
18	624.338	18.27106	0	4.90354	18.271062	0	0	149.74
18.04	624.338	18.337	0	4.90354	18.336996	0	0	150.33
18.08	620.607	18.37363	0	4.87424	18.373626	0	0	149.74
18.12	616.876	18.41026	0	4.84493	18.410256	0	0	149.74
18.16	615.632	18.45421	0	4.83516	18.454212	0	0	150.33
18.2	613.145	18.46886	0	4.81563	18.468864	0	0	149.74
18.24	615.632	18.50549	0	4.83516	18.505495	0	0	150.04
18.28	615.632	18.52747	0	4.83516	18.527473	0	0	149.45
18.32	616.876	18.57875	0	4.84493	18.578755	0	0	149.74
18.36	618.12	18.64469	0	4.8547	18.644689	0	0	149.74
18.4	614.389	18.68864	0	4.8254	18.688645	0	0	149.74
18.44	610.658	18.7326	0	4.79609	18.732601	0	0	149.74
18.48	609.414	18.7619	0	4.78632	18.761905	0	0	149.74
18.52	606.926	18.79121	0	4.76679	18.791209	0	0	149.74
18.56	609.414	18.82784	0	4.78632	18.827839	0	0	149.74
18.6	609.414	18.85714	0	4.78632	18.857143	0	0	149.74
18.64	611.901	18.89377	0	4.80586	18.893773	0	0	149.74
18.68	611.901	18.94505	0	4.80586	18.945055	0	0	149.74
18.72	609.414	19.00366	0	4.78632	19.003663	0	0	149.45
18.76	606.926	19.05495	0	4.76679	19.054945	0	0	149.74
18.8	600.708	19.0696	0	4.71795	19.069597	0	0	148.86
18.84	603.195	19.12088	0	4.73748	19.120879	0	0	150.04
18.88	601.952	19.15018	0	4.72772	19.150183	0	0	149.74
18.92	603.195	19.17216	0	4.73748	19.172161	0	0	149.74
18.96	604.439	19.20879	0	4.74725	19.208791	0	0	149.74
19	605.683	19.26007	0	4.75702	19.260073	0	0	149.74
19.04	604.439	19.31136	0	4.74725	19.311355	0	0	149.74
19.08	601.952	19.36996	0	4.72772	19.369963	0	0	149.74
19.12	598.22	19.40659	0	4.69841	19.406593	0	0	149.74
19.16	596.977	19.44322	0	4.68864	19.443223	0	0	149.74
19.2	595.733	19.4652	0	4.67888	19.465201	0	0	149.74
19.24	596.977	19.49451	0	4.68864	19.494505	0	0	149.74
19.28	600.708	19.54579	0	4.71795	19.545788	0	0	150.33
19.32	599.464	19.58242	0	4.70818	19.582418	0	0	149.74
19.36	599.464	19.6337	0	4.70818	19.6337	0	0	149.74
19.4	595.733	19.67766	0	4.67888	19.677656	0	0	149.45
19.44	594.489	19.72894	0	4.66911	19.728938	0	0	149.74
19.48	589.515	19.74359	0	4.63004	19.74359	0	0	149.16
19.52	589.515	19.78755	0	4.63004	19.787546	0	0	149.74
19.56	590.758	19.81685	0	4.6398	19.81685	0	0	149.74
19.6	593.246	19.85348	0	4.65934	19.85348	0	0	149.74
19.64	594.489	19.89744	0	4.66911	19.897436	0	0	150.04
19.68	594.489	19.94872	0	4.66911	19.948718	0	0	149.74
19.72	592.002	20	0	4.64957	20	0	0	149.74
19.76	588.271	20.04396	0	4.62027	20.043956	0	0	149.45
19.8	590.758	20.10256	0	4.6398	20.102564	0	0	150.92
19.84	585.783	20.10989	0	4.60073	20.10989	0	0	150.04
19.88	584.54	20.13919	0	4.59096	20.139194	0	0	149.74
19.92	587.027	20.1685	0	4.6105	20.168498	0	0	149.45
19.96	589.515	20.21978	0	4.63004	20.21978	0	0	150.33
20	588.271	20.25641	0	4.62027	20.25641	0	0	149.74
20.04	587.027	20.30769	0	4.6105	20.307692	0	0	149.45
20.08	584.54	20.35897	0	4.59096	20.358974	0	0	149.74
20.12	582.052	20.40293	0	4.57143	20.40293	0	0	149.74
20.16	580.809	20.43223	0	4.56166	20.432234	0	0	149.74
20.2	579.565	20.46154	0	4.55189	20.461538	0	0	149.74
20.24	580.809	20.49084	0	4.56166	20.490842	0	0	149.74
20.28	583.296	20.52747	0	4.5812	20.527473	0	0	149.74
20.32	584.54	20.57143	0	4.59096	20.571429	0	0	149.74
20.36	582.052	20.63004	0	4.57143	20.630037	0	0	149.74
20.4	580.809	20.68132	0	4.56166	20.681319	0	0	149.74
20.44	578.321	20.71795	0	4.54212	20.717949	0	0	149.74
20.48	575.834	20.75458	0	4.52259	20.754579	0	0	149.74
20.52	574.59	20.77656	0	4.51282	20.776557	0	0	149.74
20.56	577.078	20.82051	0	4.53236	20.820513	0	0	150.04
20.6	579.565	20.84982	0	4.55189	20.849817	0	0	149.74
20.64	579.565	20.89377	0	4.55189	20.893773	0	0	149.74
20.68	578.321	20.94505	0	4.54212	20.945055	0	0	149.45
20.72	575.834	20.99634	0	4.52259	20.996337	0	0	149.74
20.76	573.346	21.04029	0	4.50305	21.040293	0	0	149.74
20.8	570.859	21.06227	0	4.48352	21.062271	0	0	149.74
20.84	570.859	21.0989	0	4.48352	21.098901	0	0	149.74
20.88	570.859	21.12821	0	4.48352	21.128205	0	0	149.74
20.92	573.346	21.16484	0	4.50305	21.164835	0	0	149.74
20.96	573.346	21.20879	0	4.50305	21.208791	0	0	149.45
21	574.59	21.2674	0	4.51282	21.267399	0	0	149.74
21.04	569.615	21.31136	0	4.47375	21.311355	0	0	149.45
21.08	568.372	21.35531	0	4.46398	21.355311	0	0	149.74
21.12	565.884	21.38462	0	4.44444	21.384615	0	0	149.74
21.16	567.128	21.41392	0	4.45421	21.413919	0	0	149.74
21.2	567.128	21.44322	0	4.45421	21.443223	0	0	149.74
21.24	569.615	21.48718	0	4.47375	21.487179	0	0	149.74
21.28	569.615	21.53114	0	4.47375	21.531136	0	0	149.45
21.32	569.615	21.58974	0	4.47375	21.589744	0	0	149.74
21.36	565.884	21.6337	0	4.44444	21.6337	0	0	149.74
21.4	564.641	21.67766	0	4.43468	21.677656	0	0	149.74

21.44	562.153	21.69963	0	4.41514	21.699634	0	0	149.74
21.48	562.153	21.72894	0	4.41514	21.728938	0	0	149.74
21.52	564.641	21.76557	0	4.43468	21.765568	0	0	149.74
21.56	569.615	21.81685	0	4.47375	21.81685	0	0	150.33
21.6	567.128	21.85348	0	4.45421	21.85348	0	0	149.74
21.64	564.641	21.91209	0	4.43468	21.912088	0	0	149.74
21.68	563.397	21.9707	0	4.42491	21.970696	0	0	150.33
21.72	559.666	21.98535	0	4.3956	21.985348	0	0	149.74
21.76	557.178	22.01465	0	4.37607	22.014652	0	0	149.74
21.8	560.909	22.05128	0	4.40537	22.051282	0	0	150.33
21.84	560.909	22.08059	0	4.40537	22.080586	0	0	149.74
21.88	562.153	22.12454	0	4.41514	22.124542	0	0	149.74
21.92	563.397	22.18315	0	4.42491	22.18315	0	0	150.33
21.96	559.666	22.22711	0	4.3956	22.227106	0	0	149.74
22	552.204	22.24176	0	4.337	22.241758	0	0	148.57
22.04	557.178	22.30769	0	4.37607	22.307692	0	0	149.74
22.08	555.935	22.337	0	4.3663	22.336996	0	0	149.74
22.12	557.178	22.3663	0	4.37607	22.3663	0	0	149.74
22.16	558.422	22.40293	0	4.38584	22.40293	0	0	149.45
22.2	562.153	22.46886	0	4.41514	22.468864	0	0	150.92
22.24	557.178	22.50549	0	4.37607	22.505495	0	0	149.74
22.28	555.935	22.54945	0	4.3663	22.549451	0	0	149.74
22.32	553.447	22.57875	0	4.34676	22.578755	0	0	150.04
22.36	552.204	22.61538	0	4.337	22.615385	0	0	149.74
22.4	553.447	22.64469	0	4.34676	22.644689	0	0	149.74
22.44	555.935	22.68132	0	4.3663	22.681319	0	0	149.74
22.48	555.935	22.72527	0	4.3663	22.725275	0	0	149.45
22.52	555.935	22.77656	0	4.3663	22.776557	0	0	149.74
22.56	553.447	22.82784	0	4.34676	22.827839	0	0	149.74
22.6	550.96	22.86447	0	4.32723	22.864469	0	0	149.74
22.64	550.96	22.89377	0	4.32723	22.893773	0	0	150.04
22.68	550.96	22.92308	0	4.32723	22.923077	0	0	149.74
22.72	550.96	22.95238	0	4.32723	22.952381	0	0	149.74
22.76	554.691	23.01099	0	4.35653	23.010989	0	0	150.04
22.8	553.447	23.05495	0	4.34676	23.054945	0	0	149.74
22.84	552.204	23.0989	0	4.337	23.098901	0	0	149.74
22.88	548.472	23.14286	0	4.30769	23.142857	0	0	149.74
22.92	547.229	23.17949	0	4.29792	23.179487	0	0	149.74
22.96	547.229	23.20879	0	4.29792	23.208791	0	0	149.74
23	548.472	23.2381	0	4.30769	23.238095	0	0	149.74
23.04	550.96	23.28205	0	4.32723	23.282051	0	0	149.74
23.08	549.716	23.32601	0	4.31746	23.326007	0	0	149.74
23.12	550.96	23.38462	0	4.32723	23.384615	0	0	149.74
23.16	547.229	23.42125	0	4.29792	23.421245	0	0	149.74
23.2	544.741	23.45788	0	4.27839	23.457875	0	0	149.74
23.24	544.741	23.48718	0	4.27839	23.487179	0	0	149.74
23.28	548.472	23.53114	0	4.30769	23.531136	0	0	150.33
23.32	548.472	23.56044	0	4.30769	23.56044	0	0	149.74
23.36	549.716	23.61905	0	4.31746	23.619048	0	0	150.33
23.4	549.716	23.67033	0	4.31746	23.67033	0	0	150.33
23.44	544.741	23.70696	0	4.27839	23.70696	0	0	150.04
23.48	542.254	23.73626	0	4.25885	23.736264	0	0	149.74
23.52	543.498	23.77289	0	4.26862	23.772894	0	0	150.33
23.56	548.472	23.82418	0	4.30769	23.824176	0	0	150.92
23.6	542.254	23.82418	0	4.25885	23.824176	0	0	149.16
23.64	547.229	23.88278	0	4.29792	23.882784	0	0	149.74
23.68	545.985	23.94139	0	4.28816	23.941392	0	0	149.74
23.72	542.254	23.97802	0	4.25885	23.978022	0	0	149.74
23.76	541.01	24.01465	0	4.24908	24.014652	0	0	149.74
23.8	541.01	24.04396	0	4.24908	24.043956	0	0	149.74
23.84	542.254	24.08059	0	4.25885	24.080586	0	0	149.74
23.88	543.498	24.11722	0	4.26862	24.117216	0	0	149.74
23.92	544.741	24.1685	0	4.27839	24.168498	0	0	149.74
23.96	543.498	24.21978	0	4.26862	24.21978	0	0	149.74
24	541.01	24.25641	0	4.24908	24.25641	0	0	149.74
24.04	539.767	24.28571	0	4.23932	24.285714	0	0	149.74
24.08	538.523	24.32234	0	4.22955	24.322344	0	0	149.74
24.12	539.767	24.35897	0	4.23932	24.358974	0	0	149.74
24.16	542.254	24.40293	0	4.25885	24.40293	0	0	149.74
24.2	542.254	24.44689	0	4.25885	24.446886	0	0	149.74
24.24	538.523	24.49084	0	4.22955	24.490842	0	0	149.74
24.28	538.523	24.5348	0	4.22955	24.534799	0	0	149.74
24.32	536.035	24.5641	0	4.21001	24.564103	0	0	149.74
24.36	536.035	24.60073	0	4.21001	24.600733	0	0	149.74
24.4	537.279	24.63004	0	4.21978	24.630037	0	0	149.16
24.44	541.01	24.68132	0	4.24908	24.681319	0	0	149.74
24.48	541.01	24.73993	0	4.24908	24.739927	0	0	150.04
24.52	538.523	24.77656	0	4.22955	24.776557	0	0	149.74
24.56	536.035	24.81319	0	4.21001	24.813187	0	0	149.74
24.6	534.792	24.84249	0	4.20024	24.842491	0	0	149.74
24.64	533.548	24.86447	0	4.19048	24.864469	0	0	149.16
24.68	538.523	24.90842	0	4.22955	24.908425	0	0	149.74
24.72	539.767	24.95971	0	4.23932	24.959707	0	0	149.74
24.76	538.523	25.01099	0	4.22955	25.010989	0	0	149.74
24.8	536.035	25.05495	0	4.21001	25.054945	0	0	149.74
24.84	534.792	25.09158	0	4.20024	25.091575	0	0	149.74
24.88	534.792	25.12088	0	4.20024	25.120879	0	0	149.74
24.92	536.035	25.15751	0	4.21001	25.157509	0	0	149.74

24.96	539.767	25.21612	0	4.23932	25.216117	0	0	150.33
25	536.035	25.24542	0	4.21001	25.245421	0	0	149.45
25.04	534.792	25.28938	0	4.20024	25.289377	0	0	149.74
25.08	533.548	25.33333	0	4.19048	25.333333	0	0	150.04
25.12	532.304	25.36264	0	4.18071	25.362637	0	0	149.74
25.16	529.817	25.37729	0	4.16117	25.377289	0	0	149.16
25.2	534.792	25.42857	0	4.20024	25.428571	0	0	149.45
25.24	536.035	25.47985	0	4.21001	25.479853	0	0	149.74
25.28	534.792	25.53846	0	4.20024	25.538462	0	0	150.33
25.32	533.548	25.57509	0	4.19048	25.575092	0	0	149.74
25.36	531.061	25.6044	0	4.17094	25.604396	0	0	149.45
25.4	532.304	25.64103	0	4.18071	25.641026	0	0	150.33
25.44	533.548	25.67033	0	4.19048	25.67033	0	0	149.74
25.48	534.792	25.72161	0	4.20024	25.721612	0	0	149.45
25.52	534.792	25.76557	0	4.20024	25.765568	0	0	150.04
25.56	529.817	25.79487	0	4.16117	25.794872	0	0	149.16
25.6	531.061	25.84615	0	4.17094	25.846154	0	0	149.74
25.64	528.573	25.86813	0	4.1514	25.868132	0	0	149.45
25.68	529.817	25.91209	0	4.16117	25.912088	0	0	149.74
25.72	532.304	25.95604	0	4.18071	25.956044	0	0	149.74
25.76	533.548	26.00733	0	4.19048	26.007326	0	0	150.33
25.8	531.061	26.05128	0	4.17094	26.051282	0	0	149.74
25.84	526.086	26.06593	0	4.13187	26.065934	0	0	149.16
25.88	529.817	26.12454	0	4.16117	26.124542	0	0	150.33
25.92	529.817	26.15385	0	4.16117	26.153846	0	0	150.04
25.96	531.061	26.19048	0	4.17094	26.190476	0	0	149.74
26	531.061	26.24176	0	4.17094	26.241758	0	0	149.74
26.04	529.817	26.28571	0	4.16117	26.285714	0	0	149.74
26.08	529.817	26.337	0	4.16117	26.336996	0	0	150.33
26.12	527.329	26.35897	0	4.14164	26.358974	0	0	149.74
26.16	527.329	26.38828	0	4.14164	26.388278	0	0	149.45
26.2	528.573	26.43223	0	4.1514	26.432234	0	0	149.74
26.24	527.329	26.45421	0	4.14164	26.454212	0	0	149.16
26.28	527.329	26.52015	0	4.14164	26.520147	0	0	150.04
26.32	518.624	26.5348	0	4.07326	26.534799	0	0	149.74
26.36	512.405	26.54945	0	4.02442	26.549451	0	0	149.74
26.4	507.43	26.54945	0	3.98535	26.549451	0	0	149.74
26.44	503.699	26.54945	0	3.95604	26.549451	0	0	149.74
26.48	499.968	26.54945	0	3.92674	26.549451	0	0	149.74
26.52	497.481	26.55678	0	3.9072	26.556777	0	0	149.74
26.56	493.75	26.54945	0	3.8779	26.549451	0	0	149.74
26.6	488.775	26.54945	0	3.83883	26.549451	0	0	149.74
26.64	485.044	26.55678	0	3.80952	26.556777	0	0	150.33
26.68	477.581	26.54212	0	3.75092	26.542125	0	0	149.74
26.72	467.632	26.54212	0	3.67277	26.542125	0	0	149.74
26.76	458.926	26.5348	0	3.6044	26.534799	0	0	149.45
26.8	450.22	26.54212	0	3.53602	26.542125	0	0	150.04
26.84	437.783	26.52747	0	3.43834	26.527473	0	0	149.74
26.88	425.346	26.52747	0	3.34066	26.527473	0	0	149.16
26.92	411.665	26.52015	0	3.23321	26.520147	0	0	149.74
26.96	402.959	26.51282	0	3.16484	26.512821	0	0	149.74
27	400.472	26.51282	0	3.1453	26.512821	0	0	149.74
27.04	404.203	26.52015	0	3.1746	26.520147	0	0	149.74
27.08	416.64	26.52015	0	3.27228	26.520147	0	0	149.74
27.12	431.564	26.52015	0	3.3895	26.520147	0	0	149.74
27.16	446.489	26.52747	0	3.50672	26.527473	0	0	149.74
27.2	460.17	26.5348	0	3.61416	26.534799	0	0	149.74
27.24	471.363	26.54212	0	3.70208	26.542125	0	0	149.74
27.28	480.069	26.54945	0	3.77045	26.549451	0	0	149.74
27.32	487.531	26.54945	0	3.82906	26.549451	0	0	149.74
27.36	493.75	26.55678	0	3.8779	26.556777	0	0	149.74
27.4	496.237	26.54212	0	3.89744	26.542125	0	0	149.16
27.44	499.968	26.5641	0	3.92674	26.564103	0	0	149.74
27.48	498.724	26.55678	0	3.91697	26.556777	0	0	149.45
27.52	499.968	26.57143	0	3.92674	26.571429	0	0	149.74
27.56	499.968	26.57143	0	3.92674	26.571429	0	0	150.04
27.6	496.237	26.5641	0	3.89744	26.564103	0	0	149.45
27.64	496.237	26.57143	0	3.89744	26.571429	0	0	149.74
27.68	498.724	26.59341	0	3.91697	26.593407	0	0	150.62
27.72	494.993	26.57143	0	3.88767	26.571429	0	0	149.74
27.76	496.237	26.57875	0	3.89744	26.578755	0	0	149.74
27.8	496.237	26.57875	0	3.89744	26.578755	0	0	149.74
27.84	494.993	26.57875	0	3.88767	26.578755	0	0	149.74
27.88	494.993	26.58608	0	3.88767	26.586081	0	0	150.04
27.92	493.75	26.58608	0	3.8779	26.586081	0	0	149.74
27.96	493.75	26.58608	0	3.8779	26.586081	0	0	149.74
28	493.75	26.58608	0	3.8779	26.586081	0	0	149.74
28.04	493.75	26.59341	0	3.8779	26.593407	0	0	149.74
28.08	491.262	26.58608	0	3.85836	26.586081	0	0	149.45
28.12	493.75	26.58608	0	3.8779	26.586081	0	0	149.74
28.16	493.75	26.58608	0	3.8779	26.586081	0	0	149.74
28.2	492.506	26.59341	0	3.86813	26.593407	0	0	149.74
28.24	493.75	26.60073	0	3.8779	26.600733	0	0	149.74
28.28	492.506	26.60073	0	3.86813	26.600733	0	0	149.74
28.32	488.775	26.58608	0	3.83883	26.586081	0	0	148.86
28.36	491.262	26.59341	0	3.85836	26.593407	0	0	149.16
28.4	492.506	26.60073	0	3.86813	26.600733	0	0	149.74
28.44	494.993	26.63004	0	3.88767	26.630037	0	0	150.62

28.48	492.506	26.60806	0	3.86813	26.608059	0	0	149.74
28.52	490.018	26.60073	0	3.8486	26.600733	0	0	149.16
28.56	491.262	26.60806	0	3.85836	26.608059	0	0	149.45
28.6	491.262	26.61538	0	3.85836	26.615385	0	0	149.74
28.64	490.018	26.60806	0	3.8486	26.608059	0	0	149.74
28.68	490.018	26.61538	0	3.8486	26.615385	0	0	149.74
28.72	488.775	26.61538	0	3.83883	26.615385	0	0	149.74
28.76	488.775	26.61538	0	3.83883	26.615385	0	0	149.74
28.8	491.262	26.63004	0	3.85836	26.630037	0	0	150.62
28.84	487.531	26.61538	0	3.82906	26.615385	0	0	149.74
28.88	486.287	26.61538	0	3.81929	26.615385	0	0	149.74
28.92	486.287	26.61538	0	3.81929	26.615385	0	0	149.74
28.96	485.044	26.63004	0	3.80952	26.630037	0	0	150.04
29	488.775	26.62271	0	3.83883	26.622711	0	0	150.33
29.04	483.8	26.62271	0	3.79976	26.622711	0	0	149.74
29.08	482.556	26.61538	0	3.78999	26.615385	0	0	149.74
29.12	480.069	26.62271	0	3.77045	26.622711	0	0	149.74
29.16	480.069	26.62271	0	3.77045	26.622711	0	0	149.74
29.2	480.069	26.62271	0	3.77045	26.622711	0	0	149.74
29.24	478.825	26.62271	0	3.76068	26.622711	0	0	150.04
29.28	477.581	26.62271	0	3.75092	26.622711	0	0	149.74
29.32	477.581	26.62271	0	3.75092	26.622711	0	0	149.74
29.36	476.338	26.62271	0	3.74115	26.622711	0	0	149.74
29.4	475.094	26.62271	0	3.73138	26.622711	0	0	149.45
29.44	475.094	26.63004	0	3.73138	26.630037	0	0	149.74
29.48	475.094	26.62271	0	3.73138	26.622711	0	0	149.74
29.52	472.607	26.62271	0	3.71184	26.622711	0	0	149.74
29.56	471.363	26.61538	0	3.70208	26.615385	0	0	149.74
29.6	471.363	26.61538	0	3.70208	26.615385	0	0	149.74
29.64	467.632	26.60806	0	3.67277	26.608059	0	0	148.86
29.68	470.119	26.62271	0	3.69231	26.622711	0	0	149.74
29.72	470.119	26.62271	0	3.69231	26.622711	0	0	149.74
29.76	466.388	26.60806	0	3.663	26.608059	0	0	148.86
29.8	467.632	26.62271	0	3.67277	26.622711	0	0	149.74
29.84	467.632	26.62271	0	3.67277	26.622711	0	0	149.74
29.88	466.388	26.62271	0	3.663	26.622711	0	0	149.74
29.92	465.144	26.62271	0	3.65324	26.622711	0	0	149.74
29.96	463.901	26.61538	0	3.64347	26.615385	0	0	149.45
30	462.657	26.62271	0	3.6337	26.622711	0	0	149.74
30.04	462.657	26.62271	0	3.6337	26.622711	0	0	149.74
30.08	462.657	26.62271	0	3.6337	26.622711	0	0	150.04
30.12	460.17	26.61538	0	3.61416	26.615385	0	0	149.45
30.16	461.413	26.62271	0	3.62393	26.622711	0	0	150.04
30.2	460.17	26.61538	0	3.61416	26.615385	0	0	149.74
30.24	458.926	26.61538	0	3.6044	26.615385	0	0	149.74
30.28	457.682	26.61538	0	3.59463	26.615385	0	0	149.74
30.32	455.195	26.60806	0	3.57509	26.608059	0	0	149.16
30.36	456.438	26.62271	0	3.58486	26.622711	0	0	149.74
30.4	455.195	26.62271	0	3.57509	26.622711	0	0	149.74
30.44	453.951	26.61538	0	3.56532	26.615385	0	0	149.74
30.48	448.976	26.60073	0	3.52625	26.600733	0	0	148.86
30.52	451.464	26.61538	0	3.54579	26.615385	0	0	149.74
30.56	450.22	26.61538	0	3.53602	26.615385	0	0	149.74
30.6	450.22	26.62271	0	3.53602	26.622711	0	0	150.04
30.64	448.976	26.62271	0	3.52625	26.622711	0	0	150.04
30.68	446.489	26.61538	0	3.50672	26.615385	0	0	149.74
30.72	445.245	26.61538	0	3.49695	26.615385	0	0	149.74
30.76	446.489	26.62271	0	3.50672	26.622711	0	0	150.33
30.8	442.758	26.61538	0	3.47741	26.615385	0	0	149.74
30.84	440.27	26.61538	0	3.45788	26.615385	0	0	149.74
30.88	440.27	26.61538	0	3.45788	26.615385	0	0	150.04
30.92	437.783	26.61538	0	3.43834	26.615385	0	0	149.74
30.96	436.539	26.60806	0	3.42857	26.608059	0	0	149.74
31	435.296	26.61538	0	3.4188	26.615385	0	0	149.74
31.04	434.052	26.61538	0	3.40904	26.615385	0	0	150.04
31.08	432.808	26.60806	0	3.39927	26.608059	0	0	149.74
31.12	431.564	26.60806	0	3.3895	26.608059	0	0	149.74
31.16	430.321	26.61538	0	3.37973	26.615385	0	0	149.74
31.2	430.321	26.61538	0	3.37973	26.615385	0	0	150.04
31.24	427.833	26.60806	0	3.3602	26.608059	0	0	149.74
31.28	427.833	26.60806	0	3.3602	26.608059	0	0	149.74
31.32	427.833	26.60806	0	3.3602	26.608059	0	0	149.74
31.36	427.833	26.61538	0	3.3602	26.615385	0	0	150.33
31.4	426.59	26.60073	0	3.35043	26.600733	0	0	149.74
31.44	425.346	26.60806	0	3.34066	26.608059	0	0	149.74
31.48	426.59	26.60806	0	3.35043	26.608059	0	0	149.74
31.52	425.346	26.60806	0	3.34066	26.608059	0	0	149.74
31.56	426.59	26.60806	0	3.35043	26.608059	0	0	149.74
31.6	426.59	26.60806	0	3.35043	26.608059	0	0	149.74
31.64	427.833	26.61538	0	3.3602	26.615385	0	0	150.04
31.68	426.59	26.60806	0	3.35043	26.608059	0	0	150.04
31.72	427.833	26.60806	0	3.3602	26.608059	0	0	149.74
31.76	429.077	26.61538	0	3.36996	26.615385	0	0	150.04
31.8	427.833	26.60806	0	3.3602	26.608059	0	0	149.74
31.84	427.833	26.60806	0	3.3602	26.608059	0	0	149.74
31.88	429.077	26.60806	0	3.36996	26.608059	0	0	149.74
31.92	429.077	26.60806	0	3.36996	26.608059	0	0	149.74
31.96	429.077	26.60806	0	3.36996	26.608059	0	0	149.74

32	430.321	26.60806	0	3.37973	26.608059	0	0	149.74
32.04	430.321	26.60806	0	3.37973	26.608059	0	0	149.74
32.08	431.564	26.61538	0	3.3895	26.615385	0	0	150.04
32.12	431.564	26.60806	0	3.3895	26.608059	0	0	149.74
32.16	432.808	26.61538	0	3.39927	26.615385	0	0	149.74
32.2	434.052	26.60806	0	3.40904	26.608059	0	0	149.74
32.24	436.539	26.62271	0	3.42857	26.622711	0	0	150.33
32.28	435.296	26.61538	0	3.4188	26.615385	0	0	149.74
32.32	436.539	26.61538	0	3.42857	26.615385	0	0	150.04
32.36	437.783	26.61538	0	3.43834	26.615385	0	0	149.74
32.4	435.296	26.60073	0	3.4188	26.600733	0	0	149.45
32.44	437.783	26.60806	0	3.43834	26.608059	0	0	149.74
32.48	439.027	26.61538	0	3.44811	26.615385	0	0	149.74
32.52	439.027	26.60806	0	3.44811	26.608059	0	0	149.74
32.56	439.027	26.61538	0	3.44811	26.615385	0	0	149.74
32.6	437.783	26.60073	0	3.43834	26.600733	0	0	149.16
32.64	441.514	26.61538	0	3.46764	26.615385	0	0	150.04
32.68	440.27	26.60806	0	3.45788	26.608059	0	0	149.74
32.72	440.27	26.61538	0	3.45788	26.615385	0	0	149.74
32.76	441.514	26.61538	0	3.46764	26.615385	0	0	149.74
32.8	440.27	26.60073	0	3.45788	26.600733	0	0	149.16
32.84	442.758	26.61538	0	3.47741	26.615385	0	0	149.74
32.88	442.758	26.61538	0	3.47741	26.615385	0	0	149.45
32.92	442.758	26.61538	0	3.47741	26.615385	0	0	149.74
32.96	442.758	26.61538	0	3.47741	26.615385	0	0	149.74
33	442.758	26.61538	0	3.47741	26.615385	0	0	149.74
33.04	441.514	26.60806	0	3.46764	26.608059	0	0	149.74
33.08	442.758	26.61538	0	3.47741	26.615385	0	0	149.74
33.12	441.514	26.60806	0	3.46764	26.608059	0	0	149.74
33.16	442.758	26.61538	0	3.47741	26.615385	0	0	149.74
33.2	445.245	26.63736	0	3.49695	26.637363	0	0	150.62
33.24	440.27	26.60806	0	3.45788	26.608059	0	0	149.74
33.28	441.514	26.61538	0	3.46764	26.615385	0	0	150.04
33.32	441.514	26.61538	0	3.46764	26.615385	0	0	149.74
33.36	441.514	26.61538	0	3.46764	26.615385	0	0	149.74
33.4	442.758	26.62271	0	3.47741	26.622711	0	0	150.33
33.44	440.27	26.60806	0	3.45788	26.608059	0	0	149.74
33.48	439.027	26.61538	0	3.44811	26.615385	0	0	149.45
33.52	440.27	26.61538	0	3.45788	26.615385	0	0	149.74
33.56	440.27	26.61538	0	3.45788	26.615385	0	0	149.74
33.6	441.514	26.63004	0	3.46764	26.630037	0	0	150.33
33.64	439.027	26.61538	0	3.44811	26.615385	0	0	149.74
33.68	440.27	26.62271	0	3.45788	26.622711	0	0	150.33
33.72	439.027	26.61538	0	3.44811	26.615385	0	0	149.74
33.76	437.783	26.61538	0	3.43834	26.615385	0	0	150.04
33.8	436.539	26.60806	0	3.42857	26.608059	0	0	149.45
33.84	436.539	26.61538	0	3.42857	26.615385	0	0	149.74
33.88	436.539	26.61538	0	3.42857	26.615385	0	0	149.74
33.92	436.539	26.61538	0	3.42857	26.615385	0	0	149.74
33.96	435.296	26.61538	0	3.4188	26.615385	0	0	149.74
34	439.027	26.63004	0	3.44811	26.630037	0	0	150.33
34.04	434.052	26.61538	0	3.40904	26.615385	0	0	149.45
34.08	434.052	26.61538	0	3.40904	26.615385	0	0	149.74
34.12	435.296	26.61538	0	3.4188	26.615385	0	0	149.74
34.16	432.808	26.61538	0	3.39927	26.615385	0	0	149.74
34.2	434.052	26.61538	0	3.40904	26.615385	0	0	149.74
34.24	434.052	26.61538	0	3.40904	26.615385	0	0	150.04
34.28	432.808	26.61538	0	3.39927	26.615385	0	0	149.74
34.32	432.808	26.61538	0	3.39927	26.615385	0	0	149.74
34.36	431.564	26.61538	0	3.3895	26.615385	0	0	149.74
34.4	431.564	26.61538	0	3.3895	26.615385	0	0	149.74
34.44	430.321	26.61538	0	3.37973	26.615385	0	0	149.74
34.48	430.321	26.61538	0	3.37973	26.615385	0	0	149.74
34.52	427.833	26.60073	0	3.3602	26.600733	0	0	149.16
34.56	427.833	26.60806	0	3.3602	26.608059	0	0	149.45
34.6	430.321	26.62271	0	3.37973	26.622711	0	0	150.33
34.64	429.077	26.61538	0	3.36996	26.615385	0	0	149.74
34.68	429.077	26.61538	0	3.36996	26.615385	0	0	149.74
34.72	427.833	26.61538	0	3.3602	26.615385	0	0	149.74
34.76	427.833	26.61538	0	3.3602	26.615385	0	0	149.74
34.8	427.833	26.60806	0	3.3602	26.608059	0	0	149.74
34.84	426.59	26.61538	0	3.35043	26.615385	0	0	149.74
34.88	426.59	26.61538	0	3.35043	26.615385	0	0	149.74
34.92	427.833	26.61538	0	3.3602	26.615385	0	0	149.74
34.96	426.59	26.60806	0	3.35043	26.608059	0	0	149.74
35	426.59	26.61538	0	3.35043	26.615385	0	0	150.04

HCTCRB: confining pressure 50 kPa

IPC Global Universal Testing Machine
UTM_12 V2.00 Stress - Strain Test

Filename	D:\my research\Lab test Data\Triaxial\CR2GPC\UU-test no1\CR2GPC-triaxial-50kPa.B12							
Operator	Mr.Peerapong Jitsangiam							
Test type	Compression test							
Notes/Comments		CR2GPC						
Specimen shape	Cylindrical							
Specimen Information								
********************								
Identification	CR2GPC							
Core/Sample Number								
Dimensions	Point 1	Point 2	Point 3	Point 4	Point 5	Point 6	Average	Std Dev.
Diameter (mm)	100						100	
Height (mm)	100						100	
Cross-Sectional area	7853.982							
Volume	785398.2							
Comments/Properties								
Setup Parameters								
****************								
Pre-load stress (kPa)								
Pre-load load (kN)								
Pre-load hold time (s)								
Confining pressure (kPa)	50							
Confining hold time (s)	10							
Dump pressure at end of test	No							
Axial gauge length (mm)	100							
Radial gauge length (mm)								
Advanced loading control	Disabled							
Control Mode	Displacement (actuator)							
Loading Rate (mm/s)	1							
Termination Timer (sec)	0							
% Unload	0							
Minimum stress (kPa)	0							
Minimum load (kN)	0							
Termination Actuator (mm)	0							
Termination Axial (mm)	250							
Termination Radial (mm)	0							
Calibration Information								
***********************								
Channel description	Filename	Transducer description	Span	Units	Date	Linearised		
A: Axial Force	Y12346.CAR	STC5000 S/N: Y12346 +/- 20kN	40	kN	7/12/2005	No		
B: Actuator LVDT	941C-340.CAR	AC-15 S/N: M992941C-340 +/-15mm	30	mm	7/12/2005	No		
C: Axial LVDT #1	83047.car	D6-05000A S/N: 83047 +/- 5mm	10	mm	20/12/2005	Yes		
D: Axial LVDT #2	83048.car	D6-05000A S/N: 83048 +/- 5mm	10	mm	20/12/2005	Yes		
E: Radial LVDT #1	S054041.CAR	IT2000AG S/N: S054041 +/- 600kPa	1200	kPa	22/01/2004	No		
F: Radial LVDT #2		Undefined/Not Used	1	?		No		
G: Temperature Probe		Undefined/Not Used	1	?		No		
H: Confining Pressure	S054041.CAR	IT2000AG S/N: S054041 +/- 600kPa	1200	kPa	22/01/2004	No		
Test Results								
************								
Start date and time	Monday	December 11	2006	at 11:27 AM				
Timer (sec)	29							
Peak compressive stress (kPa)	1099.4							
Peak load (kN)	8.635							
Actuator strain at peak load (%)	4.205							
Actuator deformation at peak load (mm)	4.205							
Axial av. strain at peak load (%)	3.805							
Axial av. deform. at peak load (mm)	3.805							
Time	Stress	Actuator Strain	Axial average strain	Load	Actuator	Axial LVDT #1	Axial LVDT #2	Confining Pressure
(sec)	(kPa)	(%)	(%)	(kN)	(mm)	(mm)	(mm)	(kPa)
0	0	0	0	0	0	0	0	49.52
0.04	95.765	0.35165	0.30305	0.75214	0.351648	0.289231	0.316874	49.23
0.08	108.202	0.41758	0.34252	0.84982	0.417582	0.328694	0.356337	49.82
0.12	118.152	0.45421	0.37581	0.92796	0.454212	0.360757	0.390867	49.52
0.16	130.589	0.49817	0.41527	1.02564	0.498168	0.40022	0.43033	49.82

Appendix D: Triaxial test

0.2	143.026	0.54212	0.45347	1.12332	0.542125	0.437216	0.469719	49.52
0.24	155.463	0.58608	0.49397	1.221	0.586081	0.479145	0.508791	49.52
0.28	169.143	0.63004	0.53078	1.32845	0.630037	0.516142	0.545421	49.52
0.32	182.824	0.66667	0.56758	1.4359	0.666667	0.550672	0.584493	49.82
0.36	197.749	0.71795	0.60792	1.55311	0.717949	0.592283	0.623565	49.52
0.4	212.673	0.75458	0.64211	1.67033	0.754579	0.626471	0.657753	49.52
0.44	226.354	0.79853	0.67996	1.77778	0.798535	0.663101	0.696825	49.52
0.48	248.74	0.87179	0.72392	1.9536	0.871795	0.707057	0.740781	51.28
0.52	259.934	0.88645	0.75322	2.04151	0.886447	0.738803	0.767643	49.82
0.56	277.345	0.9304	0.78863	2.17827	0.930403	0.772991	0.804274	49.52
0.6	294.757	0.96703	0.8216	2.31502	0.967033	0.804737	0.838462	49.23
0.64	312.169	1.01099	0.85823	2.45177	1.010989	0.841368	0.875092	50.11
0.68	328.337	1.04762	0.8912	2.57875	1.047619	0.873114	0.90928	49.52
0.72	345.749	1.08425	0.92172	2.71551	1.084249	0.90486	0.938584	49.52
0.76	365.648	1.12821	0.95847	2.87179	1.128205	0.94149	0.975458	50.11
0.8	383.06	1.16484	0.98792	3.00855	1.164835	0.970794	1.005055	49.82
0.84	402.959	1.20147	1.02228	3.16484	1.201465	1.004982	1.039585	49.52
0.88	421.615	1.24542	1.05788	3.31136	1.245421	1.03917	1.076581	49.82
0.92	440.27	1.28205	1.09211	3.45788	1.282051	1.073114	1.111111	49.52
0.96	460.17	1.32601	1.1263	3.61416	1.326007	1.10696	1.145641	49.82
1	478.825	1.36264	1.15681	3.76068	1.362637	1.138388	1.175238	49.52
1.04	501.212	1.39927	1.1873	3.93651	1.399267	1.167399	1.207204	50.11
1.08	521.111	1.4359	1.21889	4.0928	1.435897	1.198828	1.23895	49.52
1.12	537.279	1.45055	1.24319	4.21978	1.450549	1.223004	1.26337	48.94
1.16	560.909	1.51648	1.2857	4.40537	1.516484	1.26652	1.304884	49.52
1.2	584.54	1.56044	1.32094	4.59096	1.56044	1.300366	1.341514	50.11
1.24	603.195	1.59707	1.35496	4.73748	1.59707	1.334212	1.375702	50.11
1.28	620.607	1.6337	1.38411	4.87424	1.6337	1.363223	1.405006	49.52
1.32	639.263	1.67766	1.42057	5.02076	1.677656	1.39707	1.444078	50.11
1.36	656.674	1.71429	1.45337	5.15751	1.714286	1.430916	1.475824	50.11
1.4	675.33	1.75092	1.48253	5.30403	1.750916	1.459927	1.505128	49.82
1.44	692.742	1.78022	1.51046	5.44078	1.78022	1.488938	1.53199	49.23
1.48	710.154	1.81685	1.54327	5.57753	1.81685	1.520366	1.566178	50.11
1.52	726.322	1.85348	1.57374	5.70452	1.85348	1.55199	1.595482	49.52
1.56	741.246	1.89011	1.60426	5.82173	1.89011	1.581294	1.627228	49.82
1.6	756.171	1.92674	1.63479	5.93895	1.92674	1.61304	1.656532	49.82
1.64	771.095	1.95604	1.66654	6.05617	1.956044	1.644786	1.688303	49.82
1.68	786.019	1.99267	1.69477	6.17338	1.992674	1.671648	1.7179	49.52
1.72	799.7	2.0293	1.72668	6.28083	2.029304	1.703394	1.749963	49.52
1.76	813.381	2.06593	1.75858	6.38828	2.065934	1.73514	1.782027	49.52
1.8	827.062	2.10256	1.79416	6.49573	2.102564	1.77177	1.816557	49.52
1.84	839.499	2.13919	1.82717	6.59341	2.139194	1.803248	1.851087	49.52
1.88	851.936	2.17582	1.86136	6.69109	2.175824	1.837094	1.885617	49.52
1.92	866.86	2.21245	1.89187	6.8083	2.212454	1.868523	1.915214	49.52
1.96	879.297	2.25641	1.9284	6.90598	2.25641	1.904786	1.952015	49.82
2	891.734	2.29304	1.95999	7.00366	2.29304	1.936215	1.983761	49.82
2.04	902.927	2.32967	1.99766	7.09158	2.32967	1.972479	2.022833	49.82
2.08	914.121	2.37363	2.03288	7.17949	2.373626	2.008742	2.057021	49.52
2.12	925.314	2.41026	2.06824	7.2674	2.410256	2.045275	2.091209	49.52
2.16	936.507	2.44689	2.10853	7.35531	2.446886	2.084347	2.132723	49.82
2.2	953.919	2.52747	2.15496	7.49206	2.527473	2.130745	2.17917	51.87
2.24	956.407	2.52747	2.18084	7.5116	2.527473	2.157607	2.204078	49.52
2.28	965.112	2.5641	2.22153	7.57998	2.564103	2.199121	2.243932	49.52
2.32	973.818	2.61538	2.26348	7.64835	2.615385	2.238193	2.288767	49.82
2.36	982.524	2.65201	2.30045	7.71673	2.652015	2.277265	2.323639	49.52
2.4	991.23	2.71062	2.34609	7.7851	2.710623	2.321221	2.370965	50.11
2.44	996.205	2.73993	2.38309	7.82418	2.739927	2.357851	2.408327	49.52
2.48	1004.911	2.78388	2.42488	7.89255	2.783883	2.401807	2.447961	49.82
2.52	1009.886	2.82784	2.46415	7.93162	2.827839	2.440879	2.487424	49.52
2.56	1018.592	2.87179	2.50464	8	2.871795	2.482393	2.526886	50.11
2.6	1026.054	2.91575	2.54514	8.05861	2.915751	2.521465	2.568816	49.82
2.64	1032.272	2.95238	2.58441	8.10745	2.952381	2.560537	2.608278	49.82
2.68	1037.247	2.99634	2.62368	8.14652	2.996337	2.599609	2.647741	49.82
2.72	1042.222	3.03297	2.6654	8.18559	3.032967	2.641123	2.68967	49.82
2.76	1047.197	3.08425	2.70956	8.22466	3.084249	2.687521	2.7316	50.11
2.8	1049.684	3.12088	2.75006	8.2442	3.120879	2.726593	2.773529	49.52
2.84	1054.659	3.17216	2.79669	8.28327	3.172161	2.772991	2.820391	49.82
2.88	1058.39	3.21612	2.84087	8.31258	3.216117	2.816947	2.864786	49.52
2.92	1062.121	3.26007	2.88503	8.34188	3.260073	2.863346	2.906716	49.82
2.96	1064.609	3.31136	2.92921	8.36142	3.311355	2.907302	2.951111	49.82
3	1065.852	3.34799	2.97338	8.37118	3.347985	2.951258	2.995507	50.11
3.04	1068.34	3.38462	3.01387	8.39072	3.384615	2.992772	3.034969	49.52
3.08	1073.315	3.44322	3.05949	8.42979	3.443223	3.037143	3.081832	50.11
3.12	1074.558	3.47985	3.09895	8.43956	3.479853	3.079072	3.118828	50.11
3.16	1075.802	3.53114	3.14335	8.44933	3.531136	3.123468	3.163223	50.11
3.2	1075.802	3.56777	3.18281	8.44933	3.567766	3.16293	3.202686	49.82
3.24	1077.046	3.6044	3.22227	8.4591	3.604396	3.202393	3.242149	50.11
3.28	1078.289	3.64103	3.2568	8.46886	3.641026	3.236923	3.276679	49.52
3.32	1080.777	3.67766	3.29241	8.4884	3.677656	3.273602	3.311209	49.52
3.36	1082.02	3.69231	3.32186	8.49817	3.692308	3.302906	3.340806	48.94
3.4	1089.483	3.75092	3.36603	8.55678	3.750916	3.346862	3.385201	50.11
3.44	1091.97	3.80952	3.41512	8.57631	3.809524	3.395702	3.43453	50.4
3.48	1086.995	3.86081	3.47156	8.53724	3.860806	3.451868	3.491258	49.82
3.52	1083.264	3.89744	3.52319	8.50794	3.897436	3.503321	3.543053	49.52
3.56	1080.777	3.94139	3.56512	8.4884	3.941392	3.547717	3.582515	49.52
3.6	1079.533	3.98535	3.59965	8.47863	3.985348	3.582247	3.617045	49.82
3.64	1078.289	4.00733	3.62924	8.46886	4.007326	3.611844	3.646642	49.52
3.68	1079.533	4.03663	3.65761	8.47863	4.03663	3.641441	3.673773	49.23

3.72	1084.508	4.07326	3.68844	8.5177	4.07326	3.671038	3.705836	49.82
3.76	1086.995	4.10256	3.72297	8.53724	4.102564	3.705568	3.740366	49.52
3.8	1090.726	4.13187	3.75499	8.56654	4.131868	3.740024	3.769963	49.23
3.84	1099.432	4.20513	3.80531	8.63492	4.205128	3.788864	3.821758	50.7
3.88	1096.945	4.22711	3.84581	8.61538	4.227106	3.827937	3.863687	49.52
3.92	1099.432	4.27839	3.89612	8.63492	4.278388	3.879219	3.913016	49.52
3.96	1096.945	4.32967	3.94151	8.61538	4.32967	3.925617	3.957411	49.23
4	1095.701	4.3663	3.98447	8.60562	4.3663	3.967131	4.001807	49.52
4.04	1094.457	4.40293	4.02374	8.59585	4.40293	4.006203	4.04127	49.52
4.08	1090.726	4.44689	4.0679	8.56654	4.446886	4.052601	4.083199	49.52
4.12	1086.995	4.49817	4.11331	8.53724	4.498168	4.096557	4.130061	49.52
4.16	1083.264	4.5348	4.15249	8.50794	4.534799	4.135629	4.169353	49.52
4.2	1080.777	4.57143	4.1879	8.4884	4.571429	4.172259	4.203541	49.52
4.24	1078.289	4.59341	4.22209	8.46886	4.593407	4.206447	4.237729	49.52
4.28	1078.289	4.63004	4.25132	8.46886	4.630037	4.235604	4.267033	49.52
4.32	1082.02	4.66667	4.28291	8.49817	4.666667	4.267033	4.298779	50.11
4.36	1084.508	4.69597	4.31449	8.5177	4.695971	4.298462	4.330525	49.82
4.4	1089.483	4.74725	4.35701	8.55678	4.747253	4.341978	4.372039	50.4
4.44	1089.483	4.79121	4.40208	8.55678	4.791209	4.385495	4.418657	50.11
4.48	1088.239	4.83516	4.45457	8.54701	4.835165	4.438681	4.470452	49.82
4.52	1084.508	4.89377	4.51228	8.5177	4.893773	4.497387	4.527179	49.82
4.56	1079.533	4.9304	4.55791	8.47863	4.930403	4.541783	4.574042	49.52
4.6	1075.802	4.97436	4.59984	8.44933	4.974359	4.583712	4.615971	49.52
4.64	1072.071	5.00366	4.63553	8.42002	5.003663	4.620708	4.650354	49.52
4.68	1070.827	5.04029	4.66972	8.41026	5.040293	4.655238	4.6842	49.52
4.72	1068.34	5.0696	4.69902	8.39072	5.069597	4.684835	4.713211	49.52
4.76	1069.583	5.0989	4.73066	8.40049	5.098901	4.716679	4.74464	49.52
4.8	1070.827	5.13553	4.76313	8.41026	5.135531	4.750183	4.776068	49.82
4.84	1073.315	5.17216	4.80042	8.42979	5.172161	4.786081	4.81475	49.52
4.88	1075.802	5.22344	4.84612	8.44933	5.223443	4.831551	4.860684	49.82
4.92	1074.558	5.27473	4.89703	8.43956	5.274725	4.881807	4.912259	49.82
4.96	1072.071	5.31868	4.94587	8.42002	5.318681	4.92967	4.962076	49.82
5	1070.827	5.36996	4.99654	8.41026	5.369963	4.981197	5.011893	50.11
5.04	1065.852	5.40659	5.03764	8.37118	5.406593	5.023541	5.051746	49.52
5.08	1063.365	5.44322	5.07625	8.35165	5.443223	5.060904	5.0916	49.82
5.12	1059.634	5.47985	5.11112	8.32234	5.479853	5.095775	5.126471	49.52
5.16	1058.39	5.51648	5.14684	8.31258	5.516484	5.133138	5.160537	49.82
5.2	1052.172	5.52381	5.17263	8.26374	5.52381	5.160537	5.184713	48.64
5.24	1054.659	5.57509	5.21065	8.28327	5.575092	5.1979	5.223394	49.52
5.28	1057.146	5.61172	5.24709	8.30281	5.611722	5.23453	5.259658	49.52
5.32	1058.39	5.65568	5.29083	8.31258	5.655678	5.278486	5.303175	49.82
5.36	1057.146	5.70696	5.34184	8.30281	5.70696	5.327326	5.356361	49.82
5.4	1054.659	5.75824	5.39317	8.28327	5.758242	5.38105	5.405299	49.82
5.44	1050.928	5.8022	5.4398	8.25397	5.802198	5.427448	5.452161	49.82
5.48	1047.197	5.84615	5.48398	8.22466	5.846154	5.471404	5.496557	49.52
5.52	1044.709	5.88278	5.52203	8.20513	5.882784	5.508034	5.53602	49.52
5.56	1039.735	5.91941	5.55761	8.16606	5.919414	5.544664	5.570549	49.52
5.6	1038.491	5.94872	5.59074	8.15629	5.948718	5.57641	5.605079	50.11
5.64	1037.247	5.98535	5.62495	8.14652	5.985348	5.61304	5.63685	49.82
5.68	1031.029	6.00733	5.65774	8.09768	6.007326	5.644786	5.670696	48.94
5.72	1032.272	6.05861	5.70391	8.10745	6.058608	5.691184	5.71663	49.82
5.76	1031.029	6.10256	5.74764	8.09768	6.102564	5.73514	5.760147	49.52
5.8	1028.541	6.13919	5.79138	8.07814	6.139194	5.779096	5.803663	49.52
5.84	1026.054	6.1978	5.8412	8.05861	6.197802	5.830379	5.852015	50.11
5.88	1019.835	6.23443	5.88156	8.00977	6.234432	5.871893	5.891233	49.52
5.92	1016.104	6.27106	5.92084	7.98046	6.271062	5.908523	5.933162	49.82
5.96	1012.373	6.30769	5.95526	7.95116	6.307692	5.942833	5.967692	49.52
6	1009.886	6.34432	5.99473	7.93162	6.344322	5.984762	6.004689	49.52
6.04	1008.642	6.38095	6.02926	7.92186	6.380952	6.016825	6.041685	50.11
6.08	1008.642	6.41758	6.06255	7.92186	6.417582	6.051355	6.073748	49.82
6.12	1008.642	6.44689	6.09832	7.92186	6.446886	6.088352	6.108278	49.52
6.16	1011.129	6.49084	6.14227	7.94139	6.490842	6.130281	6.154261	49.82
6.2	1009.886	6.54212	6.19353	7.93162	6.542125	6.182027	6.205031	49.82
6.24	1006.155	6.59341	6.25063	7.90232	6.593407	6.240635	6.260635	49.82
6.28	1001.18	6.64469	6.30166	7.86325	6.644689	6.291917	6.311404	49.52
6.32	994.961	6.68864	6.34541	7.81441	6.688645	6.335873	6.354945	49.52
6.36	989.986	6.72527	6.38326	7.77534	6.725275	6.372503	6.394017	49.52
6.4	986.255	6.75458	6.41501	7.74603	6.754579	6.404249	6.425763	49.82
6.44	985.012	6.78388	6.44192	7.73626	6.783883	6.431209	6.452625	49.52
6.48	983.768	6.81319	6.46769	7.7265	6.813187	6.458339	6.477045	49.23
6.52	985.012	6.84249	6.49714	7.73626	6.842491	6.487937	6.506349	49.52
6.56	988.743	6.87912	6.53518	7.76557	6.879121	6.524933	6.545421	49.82
6.6	991.23	6.91575	6.57812	7.7851	6.915751	6.566862	6.589377	49.52
6.64	991.23	6.97436	6.63335	7.7851	6.974359	6.62359	6.643101	50.11
6.68	987.499	7.03297	6.69584	7.7558	7.032967	6.685079	6.706593	50.11
6.72	980.037	7.09158	6.75933	7.69719	7.091575	6.748571	6.770085	50.11
6.76	971.331	7.14286	6.80939	7.62882	7.142857	6.799853	6.818926	49.52
6.8	963.869	7.17949	6.85201	7.57021	7.179487	6.841368	6.862662	49.82
6.84	955.163	7.19414	6.87874	7.50183	7.194139	6.86823	6.889255	48.94
6.88	955.163	7.2381	6.91155	7.50183	7.238095	6.902418	6.920684	49.52
6.92	955.163	7.28205	6.93957	7.50183	7.282051	6.929451	6.949695	50.11
6.96	951.432	7.28205	6.95669	7.47253	7.282051	6.949182	6.9642	49.82
7	953.919	7.31136	6.98353	7.49206	7.311355	6.973846	6.993211	49.52
7.04	957.65	7.34066	7.01527	7.52137	7.340659	7.00591	7.02464	49.52
7.08	961.381	7.39194	7.06167	7.55067	7.391941	7.052772	7.070574	49.52
7.12	960.138	7.45788	7.12882	7.5409	7.457875	7.119365	7.138266	50.11
7.16	955.163	7.51648	7.19206	7.50183	7.516484	7.183004	7.201123	49.82
7.2	947.701	7.57509	7.25009	7.44322	7.575092	7.241026	7.259145	50.11

7.24	940.238	7.62637	7.29844	7.38462	7.626374	7.28696	7.309915	49.82
7.28	932.776	7.65568	7.33107	7.32601	7.655678	7.320806	7.341343	49.82
7.32	929.045	7.68498	7.35888	7.2967	7.684982	7.347399	7.370354	50.11
7.36	925.314	7.69963	7.38063	7.2674	7.699634	7.371575	7.389695	49.23
7.4	925.314	7.72161	7.4036	7.2674	7.721612	7.393333	7.413871	49.52
7.44	927.801	7.75092	7.42795	7.28694	7.750916	7.417851	7.438046	49.52
7.48	931.533	7.78022	7.46458	7.31624	7.78022	7.454847	7.47431	49.52
7.52	932.776	7.82418	7.51098	7.32601	7.824176	7.501709	7.520244	49.52
7.56	934.02	7.89744	7.57315	7.33578	7.897436	7.56337	7.58293	50.11
7.6	927.801	7.94139	7.62784	7.28694	7.941392	7.620098	7.63558	49.52
7.64	922.827	8	7.68101	7.24786	8	7.671404	7.690623	49.82
7.68	917.852	8.04396	7.72672	7.20879	8.043956	7.717338	7.736093	49.82
7.72	914.121	8.08791	7.76402	7.17949	8.087912	7.758437	7.769597	49.52
7.76	909.146	8.10989	7.79407	7.14042	8.10989	7.785031	7.803101	49.52
7.8	906.658	8.13187	7.82306	7.12088	8.131868	7.814042	7.832088	49.52
7.84	906.658	8.17582	7.85449	7.12088	8.175824	7.84547	7.863516	49.82
7.88	905.415	8.1978	7.88471	7.11111	8.197802	7.874481	7.894945	49.82
7.92	902.927	8.21245	7.91387	7.09158	8.212454	7.903785	7.923956	48.94
7.96	909.146	8.27839	7.9615	7.14042	8.278388	7.953114	7.96989	49.52
8	910.39	8.32234	8.00788	7.15018	8.322344	7.997509	8.018242	49.52
8.04	909.146	8.37363	8.0651	7.14042	8.373626	8.054237	8.075971	49.52
8.08	905.415	8.43223	8.12342	7.11111	8.432234	8.113431	8.133407	50.11
8.12	899.196	8.48352	8.17794	7.06227	8.483516	8.169817	8.186056	49.82
8.16	890.49	8.51282	8.21662	6.99389	8.512821	8.208889	8.224347	49.23
8.2	889.247	8.5641	8.2565	6.98413	8.564103	8.247961	8.265031	50.11
8.24	885.516	8.58608	8.28432	6.95482	8.586081	8.274823	8.293822	49.52
8.28	884.272	8.61538	8.30862	6.94505	8.615385	8.299243	8.317998	49.52
8.32	883.028	8.63736	8.33414	6.93529	8.637363	8.326105	8.342173	49.52
8.36	886.759	8.65934	8.35965	6.96459	8.659341	8.350525	8.368767	49.82
8.4	890.49	8.69597	8.39366	6.99389	8.695971	8.384713	8.402613	49.82
8.44	895.465	8.74725	8.43983	7.03297	8.747253	8.431111	8.448547	50.11
8.48	894.221	8.79853	8.49814	7.0232	8.798535	8.489719	8.506569	49.82
8.52	889.247	8.87179	8.57198	6.98413	8.871795	8.562979	8.580977	49.82
8.56	879.297	8.93773	8.63725	6.90598	8.937729	8.628913	8.645592	49.52
8.6	870.591	8.98168	8.68558	6.83761	8.981685	8.675311	8.695849	49.23
8.64	866.86	9.02564	8.72426	6.8083	9.025641	8.714383	8.734139	49.82
8.68	860.642	9.04762	8.75208	6.75946	9.047619	8.743687	8.760464	49.82
8.72	856.91	9.0696	8.77026	6.73016	9.069597	8.760781	8.779731	49.52
8.76	856.91	9.09158	8.79455	6.73016	9.091575	8.785201	8.803907	49.82
8.8	856.91	9.10623	8.81277	6.73016	9.106227	8.802295	8.823248	49.52
8.84	858.154	9.12088	8.83221	6.73993	9.120879	8.821832	8.842589	48.94
8.88	868.104	9.17216	8.86866	6.81807	9.172161	8.858462	8.878852	50.11
8.92	871.835	9.20879	8.91136	6.84737	9.208791	8.902759	8.919951	49.52
8.96	871.835	9.27473	8.98215	6.84737	9.274725	8.971819	8.992479	50.11
9	865.616	9.35531	9.05664	6.79853	9.355311	9.048278	9.065006	50.11
9.04	858.154	9.41392	9.12255	6.73993	9.413919	9.112405	9.132698	50.11
9.08	851.936	9.45788	9.16266	6.69109	9.457875	9.153944	9.17138	49.82
9.12	845.717	9.47985	9.19546	6.64225	9.479853	9.18569	9.205226	49.52
9.16	840.742	9.51648	9.22462	6.60317	9.516484	9.214994	9.234237	49.23
9.2	838.255	9.53846	9.24895	6.58364	9.538462	9.239414	9.258486	49.52
9.24	835.767	9.55311	9.26971	6.5641	9.553114	9.25895	9.280464	49.23
9.28	838.255	9.58242	9.29168	6.58364	9.582418	9.280928	9.302442	49.52
9.32	843.23	9.61172	9.31733	6.62271	9.611722	9.305348	9.329304	49.52
9.36	849.448	9.64103	9.34907	6.67155	9.641026	9.337094	9.36105	50.11
9.4	854.423	9.69963	9.39825	6.71062	9.699634	9.386618	9.40989	49.82
9.44	853.179	9.75092	9.45632	6.70085	9.750916	9.441709	9.47094	49.82
9.48	849.448	9.81685	9.52524	6.67155	9.81685	9.503687	9.546789	49.52
9.52	843.23	9.88278	9.5948	6.62271	9.882784	9.565665	9.623932	50.11
9.56	834.524	9.92674	9.64706	6.55433	9.92674	9.61304	9.681074	49.52
9.6	828.305	9.9707	9.69353	6.50549	9.970696	9.654554	9.732503	49.52
9.64	823.33	10	9.72797	6.46642	10	9.6863	9.769646	49.23
9.68	819.599	10.0293	9.75408	6.43712	10.029304	9.713162	9.794994	49.23
9.72	817.112	10.05128	9.77545	6.41758	10.051282	9.732698	9.818193	49.52
9.76	815.868	10.06593	9.79687	6.40781	10.065934	9.754676	9.839072	49.52
9.8	818.356	10.09524	9.8183	6.42735	10.095238	9.776654	9.859951	49.52
9.84	822.087	10.11722	9.84449	6.45665	10.117216	9.803516	9.88547	49.52
9.88	824.574	10.15385	9.86391	6.47619	10.153846	9.837705	9.89011	49.23
9.92	827.062	10.21245	9.89199	6.49573	10.212454	9.893871	9.89011	49.82
9.96	825.818	10.29304	9.91885	6.48596	10.29304	9.947595	9.89011	50.11
10	817.112	10.35897	9.91885	6.41758	10.358974	9.947595	9.89011	49.82
10.04	810.893	10.40293	9.91885	6.36874	10.40293	9.947595	9.89011	49.82
10.08	809.65	10.45421	9.91885	6.35897	10.454212	9.947595	9.89011	50.7
10.12	800.944	10.47619	9.91885	6.2906	10.47619	9.947595	9.89011	49.82
10.16	797.213	10.49817	9.91885	6.26129	10.498168	9.947595	9.89011	49.52
10.2	794.725	10.52015	9.91885	6.24176	10.520147	9.947595	9.89011	49.23
10.24	795.969	10.54945	9.91885	6.25153	10.549451	9.947595	9.89011	49.82
10.28	798.456	10.5641	9.91885	6.27106	10.564103	9.947595	9.89011	49.52
10.32	802.188	10.59341	9.91885	6.30037	10.593407	9.947595	9.89011	49.52
10.36	808.406	10.63736	9.91885	6.34921	10.637363	9.947595	9.89011	49.52
10.4	810.893	10.7033	9.91885	6.36874	10.703297	9.947595	9.89011	49.82
10.44	807.162	10.76923	9.91885	6.33944	10.769231	9.947595	9.89011	50.11
10.48	802.188	10.82784	9.91885	6.30037	10.827839	9.947595	9.89011	50.11
10.52	797.213	10.88645	9.91885	6.26129	10.886447	9.947595	9.89011	49.82
10.56	789.751	10.90842	9.91885	6.20269	10.908425	9.947595	9.89011	49.23
10.6	787.263	10.94505	9.91885	6.18315	10.945055	9.947595	9.89011	49.52
10.64	781.045	10.94505	9.91885	6.13431	10.945055	9.947595	9.89011	48.64
10.68	781.045	10.98168	9.91885	6.13431	10.981685	9.947595	9.89011	49.23
10.72	784.776	11.01832	9.91885	6.16361	11.018315	9.947595	9.89011	49.52

10.76	788.507	11.04762	9.91885	6.19292	11.047619	9.947595	9.89011	49.52
10.8	792.238	11.07692	9.91885	6.22222	11.076923	9.947595	9.89011	49.52
10.84	794.725	11.12821	9.91885	6.24176	11.128205	9.947595	9.89011	49.82
10.88	797.213	11.19414	9.91885	6.26129	11.194139	9.947595	9.89011	50.11
10.92	792.238	11.24542	9.91885	6.22222	11.245421	9.947595	9.89011	49.23
10.96	788.507	11.30403	9.91885	6.19292	11.304029	9.947595	9.89011	49.52
11	786.019	11.35531	9.91885	6.17338	11.355311	9.947595	9.89011	50.11
11.04	783.532	11.38462	9.91885	6.15385	11.384615	9.947595	9.89011	49.52
11.08	781.045	11.42125	9.91885	6.13431	11.421245	9.947595	9.89011	49.82
11.12	777.314	11.42857	9.91885	6.10501	11.428571	9.947595	9.89011	49.23
11.16	779.801	11.4652	9.91885	6.12454	11.465201	9.947595	9.89011	49.23
11.2	781.045	11.49451	9.91885	6.13431	11.494505	9.947595	9.89011	49.52
11.24	786.019	11.53114	9.91885	6.17338	11.531136	9.947595	9.89011	49.82
11.28	787.263	11.57509	9.91885	6.18315	11.575092	9.947595	9.89011	49.52
11.32	788.507	11.64835	9.91885	6.19292	11.648352	9.947595	9.89011	50.11
11.36	782.288	11.70696	9.91885	6.14408	11.70696	9.947595	9.89011	50.11
11.4	774.826	11.74359	9.91885	6.08547	11.74359	9.947595	9.89011	49.52
11.44	771.095	11.79487	9.91885	6.05617	11.794872	9.947595	9.89011	49.52
11.48	767.364	11.82418	9.91885	6.02686	11.824176	9.947595	9.89011	50.11
11.52	763.633	11.85348	9.91885	5.99756	11.85348	9.947595	9.89011	49.52
11.56	762.389	11.88278	9.91885	5.98779	11.882784	9.947595	9.89011	49.52
11.6	762.389	11.90476	9.91885	5.98779	11.904762	9.947595	9.89011	49.52
11.64	766.12	11.94139	9.91885	6.01709	11.941392	9.947595	9.89011	50.11
11.68	768.608	11.96337	9.91885	6.03663	11.96337	9.947595	9.89011	49.52
11.72	773.582	12.00733	9.91885	6.0757	12.007326	9.947595	9.89011	49.52
11.76	774.826	12.05861	9.91885	6.08547	12.058608	9.947595	9.89011	49.52
11.8	773.582	12.13187	9.91885	6.0757	12.131868	9.947595	9.89011	49.82
11.84	767.364	12.19048	9.91885	6.02686	12.190476	9.947595	9.89011	50.11
11.88	759.902	12.24908	9.91885	5.96825	12.249084	9.947595	9.89011	49.82
11.92	756.171	12.28571	9.91885	5.93895	12.285714	9.947595	9.89011	49.82
11.96	749.952	12.30769	9.91885	5.89011	12.307692	9.947595	9.89011	49.82
12	747.465	12.32967	9.91885	5.87057	12.32967	9.947595	9.89011	49.52
12.04	748.708	12.35897	9.91885	5.88034	12.358974	9.947595	9.89011	50.11
12.08	748.708	12.37363	9.91885	5.88034	12.373626	9.947595	9.89011	49.52
12.12	752.439	12.40293	9.91885	5.90965	12.40293	9.947595	9.89011	49.52
12.16	757.414	12.43956	9.91885	5.94872	12.43956	9.947595	9.89011	49.52
12.2	761.145	12.48352	9.91885	5.97802	12.483516	9.947595	9.89011	49.82
12.24	761.145	12.54945	9.91885	5.97802	12.549451	9.947595	9.89011	49.82
12.28	757.414	12.61538	9.91885	5.94872	12.615385	9.947595	9.89011	49.82
12.32	752.439	12.68864	9.91885	5.90965	12.688645	9.947595	9.89011	50.11
12.36	743.734	12.7326	9.91885	5.84127	12.732601	9.947595	9.89011	49.82
12.4	737.515	12.76923	9.91885	5.79243	12.769231	9.947595	9.89011	49.82
12.44	732.54	12.78388	9.91885	5.75336	12.783883	9.947595	9.89011	49.52
12.48	728.809	12.81319	9.91885	5.72405	12.813187	9.947595	9.89011	49.52
12.52	731.297	12.83516	9.91885	5.74359	12.835165	9.947595	9.89011	50.11
12.56	730.053	12.84249	9.91885	5.73382	12.842491	9.947595	9.89011	49.52
12.6	735.028	12.87179	9.91885	5.77289	12.871795	9.947595	9.89011	49.52
12.64	741.246	12.90842	9.91885	5.82173	12.908425	9.947595	9.89011	49.82
12.68	744.977	12.95238	9.91885	5.85104	12.952381	9.947595	9.89011	49.52
12.72	746.221	13.02564	9.91885	5.86081	13.025641	9.947595	9.89011	49.52
12.76	740.002	13.09158	9.91885	5.81197	13.091575	9.947595	9.89011	49.82
12.8	736.271	13.15751	9.91885	5.78266	13.157509	9.947595	9.89011	50.11
12.84	730.053	13.18681	9.91885	5.73382	13.186813	9.947595	9.89011	49.52
12.88	726.322	13.21612	9.91885	5.70452	13.216117	9.947595	9.89011	50.11
12.92	722.591	13.2381	9.91885	5.67521	13.238095	9.947595	9.89011	49.52
12.96	722.591	13.2674	9.91885	5.67521	13.267399	9.947595	9.89011	49.82
13	723.834	13.28938	9.91885	5.68498	13.289377	9.947595	9.89011	49.52
13.04	727.565	13.31868	9.91885	5.71429	13.318681	9.947595	9.89011	49.23
13.08	731.297	13.34799	9.91885	5.74359	13.347985	9.947595	9.89011	49.52
13.12	735.028	13.39927	9.91885	5.77289	13.399267	9.947595	9.89011	49.52
13.16	735.028	13.4652	9.91885	5.77289	13.465201	9.947595	9.89011	49.82
13.2	732.54	13.53114	9.91885	5.75336	13.531136	9.947595	9.89011	50.11
13.24	727.565	13.58242	9.91885	5.71429	13.582418	9.947595	9.89011	49.82
13.28	723.834	13.62637	9.91885	5.68498	13.626374	9.947595	9.89011	49.82
13.32	718.86	13.663	9.91885	5.64591	13.663004	9.947595	9.89011	49.82
13.36	715.128	13.69231	9.91885	5.61661	13.692308	9.947595	9.89011	49.52
13.4	713.885	13.71429	9.91885	5.60684	13.714286	9.947595	9.89011	49.52
13.44	712.641	13.74359	9.91885	5.59707	13.74359	9.947595	9.89011	49.23
13.48	713.885	13.76557	9.91885	5.60684	13.765568	9.947595	9.89011	49.52
13.52	717.616	13.80952	9.91885	5.63614	13.809524	9.947595	9.89011	49.82
13.56	720.103	13.84615	9.91885	5.65568	13.846154	9.947595	9.89011	49.82
13.6	722.591	13.89744	9.91885	5.67521	13.897436	9.947595	9.89011	49.52
13.64	722.591	13.96337	9.91885	5.67521	13.96337	9.947595	9.89011	50.11
13.68	718.86	14.0293	9.91885	5.64591	14.029304	9.947595	9.89011	50.11
13.72	712.641	14.07326	9.91885	5.59707	14.07326	9.947595	9.89011	49.82
13.76	707.666	14.10989	9.91885	5.558	14.10989	9.947595	9.89011	49.82
13.8	703.935	14.15385	9.91885	5.52869	14.153846	9.947595	9.89011	50.11
13.84	700.204	14.17582	9.91885	5.49939	14.175824	9.947595	9.89011	49.52
13.88	697.717	14.1978	9.91885	5.47985	14.197802	9.947595	9.89011	49.52
13.92	697.717	14.21978	9.91885	5.47985	14.21978	9.947595	9.89011	49.82
13.96	698.96	14.24908	9.91885	5.48962	14.249084	9.947595	9.89011	49.52
14	703.935	14.27839	9.91885	5.52869	14.278388	9.947595	9.89011	50.11
14.04	707.666	14.31502	9.91885	5.558	14.315018	9.947595	9.89011	49.52
14.08	710.154	14.35897	9.91885	5.57753	14.358974	9.947595	9.89011	49.52
14.12	710.154	14.41758	9.91885	5.57753	14.417582	9.947595	9.89011	49.52
14.16	708.91	14.49084	9.91885	5.56777	14.490842	9.947595	9.89011	50.11
14.2	703.935	14.54945	9.91885	5.52869	14.549451	9.947595	9.89011	50.11
14.24	697.717	14.60073	9.91885	5.47985	14.600733	9.947595	9.89011	49.52

14.28	693.986	14.63004	9.91885	5.45055	14.630037	9.947595	9.89011	50.11
14.32	690.254	14.65934	9.91885	5.42125	14.659341	9.947595	9.89011	49.52
14.36	687.767	14.67399	9.91885	5.40171	14.673993	9.947595	9.89011	49.23
14.4	687.767	14.7033	9.91885	5.40171	14.703297	9.947595	9.89011	49.52
14.44	690.254	14.71795	9.91885	5.42125	14.717949	9.947595	9.89011	49.52
14.48	695.229	14.74725	9.91885	5.46032	14.747253	9.947595	9.89011	49.82
14.52	700.204	14.79121	9.91885	5.49939	14.791209	9.947595	9.89011	50.11
14.56	703.935	14.85714	9.91885	5.52869	14.857143	9.947595	9.89011	50.7
14.6	698.96	14.91575	9.91885	5.48962	14.915751	9.947595	9.89011	49.52
14.64	695.229	14.98168	9.91885	5.46032	14.981685	9.947595	9.89011	49.82
14.68	690.254	15.01832	9.91885	5.42125	15.018315	9.947595	9.89011	49.82
14.72	687.767	15.04762	9.91885	5.40171	15.047619	9.947595	9.89011	49.52
14.76	686.523	15.07692	9.91885	5.39194	15.076923	9.947595	9.89011	49.82
14.8	684.036	15.09158	9.91885	5.37241	15.091575	9.947595	9.89011	49.52
14.84	687.767	15.12088	9.91885	5.40171	15.120879	9.947595	9.89011	49.52
14.88	691.498	15.15751	9.91885	5.43101	15.157509	9.947595	9.89011	50.11
14.92	695.229	15.19414	9.91885	5.46032	15.194139	9.947595	9.89011	49.52
14.96	697.717	15.24542	9.91885	5.47985	15.245421	9.947595	9.89011	50.11
15	696.473	15.31868	9.91885	5.47009	15.318681	9.947595	9.89011	50.11
15.04	690.254	15.37729	9.91885	5.42125	15.377289	9.947595	9.89011	49.52
15.08	686.523	15.42857	9.91885	5.39194	15.428571	9.947595	9.89011	49.82
15.12	681.548	15.45055	9.91885	5.35287	15.450549	9.947595	9.89011	49.52
15.16	680.305	15.48718	9.91885	5.3431	15.487179	9.947595	9.89011	49.82
15.2	679.061	15.50916	9.91885	5.33333	15.509158	9.947595	9.89011	49.52
15.24	679.061	15.53114	9.91885	5.33333	15.531136	9.947595	9.89011	49.52
15.28	680.305	15.55311	9.91885	5.3431	15.553114	9.947595	9.89011	48.94
15.32	686.523	15.58242	9.91885	5.39194	15.582418	9.947595	9.89011	49.52
15.36	689.011	15.6337	9.91885	5.41148	15.6337	9.947595	9.89011	49.82
15.4	689.011	15.68498	9.91885	5.41148	15.684982	9.947595	9.89011	49.52
15.44	689.011	15.75092	9.91885	5.41148	15.750916	9.947595	9.89011	49.82
15.48	686.523	15.81685	9.91885	5.39194	15.81685	9.947595	9.89011	49.82
15.52	680.305	15.85348	9.91885	5.3431	15.85348	9.947595	9.89011	49.82
15.56	677.817	15.88278	9.91885	5.32357	15.882784	9.947595	9.89011	50.11
15.6	675.33	15.91209	9.91885	5.30403	15.912088	9.947595	9.89011	49.52
15.64	669.111	15.89744	9.91885	5.25519	15.897436	9.947595	9.89011	48.35
15.68	677.817	15.96337	9.91885	5.32357	15.96337	9.947595	9.89011	49.82
15.72	680.305	15.98535	9.91885	5.3431	15.985348	9.947595	9.89011	49.52
15.76	689.011	16.05861	9.91885	5.41148	16.058608	9.947595	9.89011	51.28
15.8	686.523	16.08059	9.91885	5.39194	16.080586	9.947595	9.89011	49.82
15.84	686.523	16.14652	9.91885	5.39194	16.14652	9.947595	9.89011	49.82
15.88	682.792	16.21245	9.91885	5.36264	16.212454	9.947595	9.89011	50.11
15.92	677.817	16.24908	9.91885	5.32357	16.249084	9.947595	9.89011	50.11
15.96	674.086	16.28571	9.91885	5.29426	16.285714	9.947595	9.89011	49.52
16	671.599	16.31502	9.91885	5.27473	16.315018	9.947595	9.89011	49.82
16.04	670.355	16.337	9.91885	5.26496	16.336996	9.947595	9.89011	49.82
16.08	671.599	16.35897	9.91885	5.27473	16.358974	9.947595	9.89011	49.52
16.12	672.843	16.38828	9.91885	5.28449	16.388278	9.947595	9.89011	49.52
16.16	679.061	16.43223	9.91885	5.33333	16.432234	9.947595	9.89011	49.82
16.2	681.548	16.46886	9.91885	5.35287	16.468864	9.947595	9.89011	49.52
16.24	682.792	16.52015	9.91885	5.36264	16.520147	9.947595	9.89011	49.23
16.28	681.548	16.58608	9.91885	5.35287	16.586081	9.947595	9.89011	49.52
16.32	676.574	16.65934	9.91885	5.3138	16.659341	9.947595	9.89011	49.82
16.36	671.599	16.7033	9.91885	5.27473	16.703297	9.947595	9.89011	49.82
16.4	667.868	16.7326	9.91885	5.24542	16.732601	9.947595	9.89011	49.82
16.44	664.137	16.7619	9.91885	5.21612	16.761905	9.947595	9.89011	49.82
16.48	662.893	16.78388	9.91885	5.20635	16.783883	9.947595	9.89011	49.82
16.52	662.893	16.79853	9.91885	5.20635	16.798535	9.947595	9.89011	49.23
16.56	666.624	16.82051	9.91885	5.23565	16.820513	9.947595	9.89011	49.52
16.6	671.599	16.85714	9.91885	5.27473	16.857143	9.947595	9.89011	49.82
16.64	675.33	16.9011	9.91885	5.30403	16.901099	9.947595	9.89011	49.52
16.68	677.817	16.95238	9.91885	5.32357	16.952381	9.947595	9.89011	49.52
16.72	677.817	17.02564	9.91885	5.32357	17.025641	9.947595	9.89011	49.52
16.76	675.33	17.08425	9.91885	5.30403	17.084249	9.947595	9.89011	50.11
16.8	670.355	17.12821	9.91885	5.26496	17.128205	9.947595	9.89011	50.11
16.84	670.355	17.17216	9.91885	5.26496	17.172161	9.947595	9.89011	50.7
16.88	664.137	17.17949	9.91885	5.21612	17.179487	9.947595	9.89011	49.52
16.92	662.893	17.20879	9.91885	5.20635	17.208791	9.947595	9.89011	49.52
16.96	664.137	17.23077	9.91885	5.21612	17.230769	9.947595	9.89011	49.52
17	669.111	17.27473	9.91885	5.25519	17.274725	9.947595	9.89011	49.82
17.04	670.355	17.30403	9.91885	5.26496	17.304029	9.947595	9.89011	49.52
17.08	675.33	17.34799	9.91885	5.30403	17.347985	9.947595	9.89011	49.82
17.12	677.817	17.40659	9.91885	5.32357	17.406593	9.947595	9.89011	49.82
17.16	675.33	17.4652	9.91885	5.30403	17.465201	9.947595	9.89011	49.82
17.2	672.843	17.51648	9.91885	5.28449	17.516484	9.947595	9.89011	49.52
17.24	669.111	17.56044	9.91885	5.25519	17.56044	9.947595	9.89011	49.52
17.28	666.624	17.59707	9.91885	5.23565	17.59707	9.947595	9.89011	49.82
17.32	662.893	17.6044	9.91885	5.20635	17.604396	9.947595	9.89011	48.94
17.36	665.38	17.64103	9.91885	5.22589	17.641026	9.947595	9.89011	49.82
17.4	669.111	17.68498	9.91885	5.25519	17.684982	9.947595	9.89011	50.4
17.44	671.599	17.70696	9.91885	5.27473	17.70696	9.947595	9.89011	50.11
17.48	674.086	17.74359	9.91885	5.29426	17.74359	9.947595	9.89011	49.82
17.52	675.33	17.8022	9.91885	5.30403	17.802198	9.947595	9.89011	49.52
17.56	672.843	17.86813	9.91885	5.28449	17.868132	9.947595	9.89011	49.52
17.6	669.111	17.91941	9.91885	5.25519	17.919414	9.947595	9.89011	49.52
17.64	664.137	17.95604	9.91885	5.21612	17.956044	9.947595	9.89011	49.52
17.68	661.649	17.99267	9.91885	5.19658	17.992674	9.947595	9.89011	49.52
17.72	659.162	18.01465	9.91885	5.17705	18.014652	9.947595	9.89011	49.52
17.76	659.162	18.03663	9.91885	5.17705	18.03663	9.947595	9.89011	49.82

17.8	660.406	18.05861	9.91885	5.18681	18.058608	9.947595	9.89011	49.52
17.84	666.624	18.09524	9.91885	5.23565	18.095238	9.947595	9.89011	49.52
17.88	671.599	18.13919	9.91885	5.27473	18.139194	9.947595	9.89011	49.82
17.92	672.843	18.19048	9.91885	5.28449	18.190476	9.947595	9.89011	49.82
17.96	671.599	18.24908	9.91885	5.27473	18.249084	9.947595	9.89011	49.52
18	671.599	18.30769	9.91885	5.27473	18.307692	9.947595	9.89011	50.11
18.04	667.868	18.34432	9.91885	5.24542	18.344322	9.947595	9.89011	49.52
18.08	665.38	18.37363	9.91885	5.22589	18.373626	9.947595	9.89011	49.52
18.12	664.137	18.40293	9.91885	5.21612	18.40293	9.947595	9.89011	49.52
18.16	665.38	18.43223	9.91885	5.22589	18.432234	9.947595	9.89011	49.52
18.2	667.868	18.46886	9.91885	5.24542	18.468864	9.947595	9.89011	49.52
18.24	662.893	18.45421	9.91885	5.20635	18.454212	9.947595	9.89011	47.77
18.28	679.061	18.58608	9.91885	5.33333	18.586081	9.947595	9.89011	50.99
18.32	674.086	18.60806	9.91885	5.29426	18.608059	9.947595	9.89011	49.52
18.36	672.843	18.67399	9.91885	5.28449	18.673993	9.947595	9.89011	50.11
18.4	667.868	18.71795	9.91885	5.24542	18.717949	9.947595	9.89011	49.82
18.44	661.649	18.73993	9.91885	5.19658	18.739927	9.947595	9.89011	49.23
18.48	660.406	18.79121	9.91885	5.18681	18.791209	9.947595	9.89011	49.82
18.52	659.162	18.81319	9.91885	5.17705	18.813187	9.947595	9.89011	49.52
18.56	659.162	18.82784	9.91885	5.17705	18.827839	9.947595	9.89011	49.52
18.6	662.893	18.85714	9.91885	5.20635	18.857143	9.947595	9.89011	49.52
18.64	667.868	18.89377	9.91885	5.24542	18.893773	9.947595	9.89011	49.82
18.68	671.599	18.9304	9.91885	5.27473	18.930403	9.947595	9.89011	49.52
18.72	671.599	18.97436	9.91885	5.27473	18.974359	9.947595	9.89011	48.64
18.76	672.843	19.05495	9.91885	5.28449	19.054945	9.947595	9.89011	49.82
18.8	666.624	19.10623	9.91885	5.23565	19.106227	9.947595	9.89011	49.23
18.84	664.137	19.15018	9.91885	5.21612	19.150183	9.947595	9.89011	49.52
18.88	662.893	19.18681	9.91885	5.20635	19.186813	9.947595	9.89011	50.11
18.92	660.406	19.21612	9.91885	5.18681	19.216117	9.947595	9.89011	50.11
18.96	660.406	19.2381	9.91885	5.18681	19.238095	9.947595	9.89011	49.82
19	661.649	19.2674	9.91885	5.19658	19.267399	9.947595	9.89011	49.82
19.04	664.137	19.28938	9.91885	5.21612	19.289377	9.947595	9.89011	49.52
19.08	667.868	19.33333	9.91885	5.24542	19.333333	9.947595	9.89011	49.82
19.12	670.355	19.38462	9.91885	5.26496	19.384615	9.947595	9.89011	50.11
19.16	669.111	19.44322	9.91885	5.25519	19.443223	9.947595	9.89011	49.52
19.2	666.624	19.50183	9.91885	5.23565	19.501832	9.947595	9.89011	49.52
19.24	662.893	19.54579	9.91885	5.20635	19.545788	9.947595	9.89011	49.52
19.28	659.162	19.58974	9.91885	5.17705	19.589744	9.947595	9.89011	50.11
19.32	657.918	19.6044	9.91885	5.16728	19.604396	9.947595	9.89011	49.52
19.36	657.918	19.6337	9.91885	5.16728	19.6337	9.947595	9.89011	49.82
19.4	659.162	19.663	9.91885	5.17705	19.663004	9.947595	9.89011	49.52
19.44	661.649	19.69231	9.91885	5.19658	19.692308	9.947595	9.89011	49.52
19.48	666.624	19.72161	9.91885	5.23565	19.721612	9.947595	9.89011	49.82
19.52	667.868	19.78022	9.91885	5.24542	19.78022	9.947595	9.89011	49.52
19.56	667.868	19.8315	9.91885	5.24542	19.831502	9.947595	9.89011	49.23
19.6	666.624	19.89744	9.91885	5.23565	19.897436	9.947595	9.89011	49.52
19.64	664.137	19.94139	9.91885	5.21612	19.941392	9.947595	9.89011	49.52
19.68	659.162	19.9707	9.91885	5.17705	19.970696	9.947595	9.89011	48.94
19.72	659.162	20	9.91885	5.17705	20	9.947595	9.89011	49.52
19.76	657.918	20.01465	9.91885	5.16728	20.014652	9.947595	9.89011	49.52
19.8	661.649	20.05861	9.91885	5.19658	20.058608	9.947595	9.89011	49.82
19.84	664.137	20.09524	9.91885	5.21612	20.095238	9.947595	9.89011	49.82
19.88	666.624	20.13187	9.91885	5.23565	20.131868	9.947595	9.89011	49.52
19.92	669.111	20.1978	9.91885	5.25519	20.197802	9.947595	9.89011	49.82
19.96	667.868	20.25641	9.91885	5.24542	20.25641	9.947595	9.89011	50.11
20	664.137	20.29304	9.91885	5.21612	20.29304	9.947595	9.89011	49.52
20.04	662.893	20.32967	9.91885	5.20635	20.32967	9.947595	9.89011	49.52
20.08	661.649	20.35897	9.91885	5.19658	20.358974	9.947595	9.89011	49.52
20.12	664.137	20.38095	9.91885	5.21612	20.380952	9.947595	9.89011	49.82
20.16	666.624	20.41026	9.91885	5.23565	20.410256	9.947595	9.89011	49.52
20.2	671.599	20.44689	9.91885	5.27473	20.446886	9.947595	9.89011	49.82
20.24	675.33	20.49817	9.91885	5.30403	20.498168	9.947595	9.89011	49.52
20.28	676.574	20.55678	9.91885	5.3138	20.556777	9.947595	9.89011	49.82
20.32	672.843	20.62271	9.91885	5.28449	20.622711	9.947595	9.89011	49.52
20.36	657.918	20.62271	9.91885	5.16728	20.622711	9.947595	9.89011	46.89
20.4	662.893	20.7033	9.91885	5.20635	20.703297	9.947595	9.89011	49.52
20.44	661.649	20.73993	9.91885	5.19658	20.739927	9.947595	9.89011	49.52
20.48	660.406	20.7619	9.91885	5.18681	20.761905	9.947595	9.89011	49.52
20.52	657.918	20.78388	9.91885	5.16728	20.783883	9.947595	9.89011	49.52
20.56	661.649	20.81319	9.91885	5.19658	20.813187	9.947595	9.89011	49.52
20.6	666.624	20.84249	9.91885	5.23565	20.842491	9.947595	9.89011	49.82
20.64	670.355	20.89377	9.91885	5.26496	20.893773	9.947595	9.89011	49.82
20.68	671.599	20.94505	9.91885	5.27473	20.945055	9.947595	9.89011	49.52
20.72	670.355	20.99634	9.91885	5.26496	20.996337	9.947595	9.89011	49.23
20.76	669.111	21.05495	9.91885	5.25519	21.054945	9.947595	9.89011	49.82
20.8	670.355	21.10623	9.91885	5.26496	21.106227	9.947595	9.89011	50.7
20.84	659.162	21.14286	9.91885	5.17705	21.142857	9.947595	9.89011	49.52
20.88	659.162	21.19414	9.91885	5.17705	21.194139	9.947595	9.89011	50.7
20.92	651.7	21.21612	9.91885	5.11844	21.216117	9.947595	9.89011	50.11
20.96	649.212	21.23077	9.91885	5.0989	21.230769	9.947595	9.89011	49.52
21	650.456	21.25275	9.91885	5.10867	21.252747	9.947595	9.89011	49.82
21.04	652.943	21.27473	9.91885	5.12821	21.274725	9.947595	9.89011	49.82
21.08	657.918	21.30403	9.91885	5.16728	21.304029	9.947595	9.89011	49.82
21.12	664.137	21.34799	9.91885	5.21612	21.347985	9.947595	9.89011	49.52
21.16	666.624	21.41392	9.91885	5.23565	21.413919	9.947595	9.89011	49.52
21.2	664.137	21.47253	9.91885	5.21612	21.472527	9.947595	9.89011	49.23
21.24	661.649	21.53114	9.91885	5.19658	21.531136	9.947595	9.89011	49.82
21.28	657.918	21.57509	9.91885	5.16728	21.575092	9.947595	9.89011	49.82

21.32	652.943	21.61905	9.91885	5.12821	21.619048	9.947595	9.89011	50.11
21.36	650.456	21.64835	9.91885	5.10867	21.648352	9.947595	9.89011	49.82
21.4	647.969	21.67766	9.91885	5.08913	21.677656	9.947595	9.89011	49.82
21.44	647.969	21.69963	9.91885	5.08913	21.699634	9.947595	9.89011	49.82
21.48	650.456	21.72161	9.91885	5.10867	21.721612	9.947595	9.89011	49.52
21.52	655.431	21.75824	9.91885	5.14774	21.758242	9.947595	9.89011	49.82
21.56	661.649	21.8022	9.91885	5.19658	21.802198	9.947595	9.89011	50.11
21.6	661.649	21.84615	9.91885	5.19658	21.846154	9.947595	9.89011	50.11
21.64	660.406	21.91209	9.91885	5.18681	21.912088	9.947595	9.89011	49.52
21.68	657.918	21.9707	9.91885	5.16728	21.970696	9.947595	9.89011	49.82
21.72	656.674	22.02198	9.91885	5.15751	22.021978	9.947595	9.89011	50.11
21.76	652.943	22.05128	9.91885	5.12821	22.051282	9.947595	9.89011	49.82
21.8	650.456	22.07326	9.91885	5.10867	22.07326	9.947595	9.89011	49.52
21.84	651.7	22.10256	9.91885	5.11844	22.102564	9.947595	9.89011	49.82
21.88	652.943	22.12454	9.91885	5.12821	22.124542	9.947595	9.89011	49.52
21.92	657.918	22.16117	9.91885	5.16728	22.161172	9.947595	9.89011	49.52
21.96	661.649	22.20513	9.91885	5.19658	22.205128	9.947595	9.89011	49.52
22	662.893	22.25641	9.91885	5.20635	22.25641	9.947595	9.89011	49.52
22.04	661.649	22.32234	9.91885	5.19658	22.322344	9.947595	9.89011	49.82
22.08	659.162	22.3663	9.91885	5.17705	22.3663	9.947595	9.89011	49.52
22.12	656.674	22.41026	9.91885	5.15751	22.410256	9.947595	9.89011	49.82
22.16	654.187	22.43223	9.91885	5.13797	22.432234	9.947595	9.89011	49.52
22.2	654.187	22.46154	9.91885	5.13797	22.461538	9.947595	9.89011	49.52
22.24	654.187	22.48352	9.91885	5.13797	22.483516	9.947595	9.89011	49.23
22.28	657.918	22.52747	9.91885	5.16728	22.527473	9.947595	9.89011	49.82
22.32	660.406	22.57143	9.91885	5.18681	22.571429	9.947595	9.89011	49.52
22.36	661.649	22.62271	9.91885	5.19658	22.622711	9.947595	9.89011	49.52
22.4	659.162	22.66667	9.91885	5.17705	22.666667	9.947595	9.89011	49.52
22.44	659.162	22.71795	9.91885	5.17705	22.717949	9.947595	9.89011	49.23
22.48	656.674	22.7619	9.91885	5.15751	22.761905	9.947595	9.89011	49.82
22.52	654.187	22.79121	9.91885	5.13797	22.791209	9.947595	9.89011	49.52
22.56	654.187	22.82051	9.91885	5.13797	22.820513	9.947595	9.89011	49.52
22.6	655.431	22.85714	9.91885	5.14774	22.857143	9.947595	9.89011	49.82
22.64	657.918	22.87912	9.91885	5.16728	22.879121	9.947595	9.89011	49.82
22.68	660.406	22.91575	9.91885	5.18681	22.915751	9.947595	9.89011	48.94
22.72	666.624	22.96703	9.91885	5.23565	22.967033	9.947595	9.89011	49.52
22.76	666.624	23.02564	9.91885	5.23565	23.025641	9.947595	9.89011	49.82
22.8	662.893	23.08425	9.91885	5.20635	23.084249	9.947595	9.89011	49.52
22.84	659.162	23.14286	9.91885	5.17705	23.142857	9.947595	9.89011	50.11
22.88	654.187	23.17216	9.91885	5.13797	23.172161	9.947595	9.89011	49.52
22.92	651.7	23.20147	9.91885	5.11844	23.201465	9.947595	9.89011	49.52
22.96	650.456	23.22344	9.91885	5.10867	23.223443	9.947595	9.89011	49.52
23	651.7	23.24542	9.91885	5.11844	23.245421	9.947595	9.89011	50.11
23.04	654.187	23.27473	9.91885	5.13797	23.274725	9.947595	9.89011	49.52
23.08	659.162	23.31868	9.91885	5.17705	23.318681	9.947595	9.89011	49.82
23.12	662.893	23.36264	9.91885	5.20635	23.362637	9.947595	9.89011	49.82
23.16	665.38	23.42857	9.91885	5.22589	23.428571	9.947595	9.89011	49.82
23.2	664.137	23.4652	9.91885	5.21612	23.465201	9.947595	9.89011	49.52
23.24	661.649	23.51648	9.91885	5.19658	23.516484	9.947595	9.89011	49.52
23.28	659.162	23.56044	9.91885	5.17705	23.56044	9.947595	9.89011	49.52
23.32	657.918	23.58974	9.91885	5.16728	23.589744	9.947595	9.89011	49.52
23.36	656.674	23.61172	9.91885	5.15751	23.611722	9.947595	9.89011	49.82
23.4	657.918	23.64835	9.91885	5.16728	23.648352	9.947595	9.89011	49.52
23.44	660.406	23.69231	9.91885	5.18681	23.692308	9.947595	9.89011	50.11
23.48	660.406	23.73626	9.91885	5.18681	23.736264	9.947595	9.89011	49.82
23.52	662.893	23.80952	9.91885	5.20635	23.809524	9.947595	9.89011	50.7
23.56	657.918	23.82418	9.91885	5.16728	23.824176	9.947595	9.89011	49.82
23.6	655.431	23.86813	9.91885	5.14774	23.868132	9.947595	9.89011	49.52
23.64	654.187	23.91941	9.91885	5.13797	23.919414	9.947595	9.89011	50.11
23.68	647.969	23.92674	9.91885	5.08913	23.92674	9.947595	9.89011	48.94
23.72	651.7	23.9707	9.91885	5.11844	23.970696	9.947595	9.89011	49.52
23.76	652.943	24	9.91885	5.12821	24	9.947595	9.89011	49.52
23.8	654.187	24.04396	9.91885	5.13797	24.043956	9.947595	9.89011	49.82
23.84	651.7	24.08059	9.91885	5.11844	24.080586	9.947595	9.89011	49.23
23.88	654.187	24.15385	9.91885	5.13797	24.153846	9.947595	9.89011	49.52
23.92	650.456	24.1978	9.91885	5.10867	24.197802	9.947595	9.89011	49.82
23.96	645.481	24.24176	9.91885	5.0696	24.241758	9.947595	9.89011	49.82
24	636.775	24.24176	9.91885	5.00122	24.241758	9.947595	9.89011	48.94
24.04	640.506	24.29304	9.91885	5.03053	24.29304	9.947595	9.89011	49.52
24.08	641.75	24.32234	9.91885	5.04029	24.322344	9.947595	9.89011	49.82
24.12	646.725	24.35165	9.91885	5.07937	24.351648	9.947595	9.89011	49.82
24.16	651.7	24.38828	9.91885	5.11844	24.388278	9.947595	9.89011	49.82
24.2	655.431	24.42491	9.91885	5.14774	24.424908	9.947595	9.89011	49.52
24.24	657.918	24.48352	9.91885	5.16728	24.483516	9.947595	9.89011	49.52
24.28	656.674	24.54212	9.91885	5.15751	24.542125	9.947595	9.89011	49.23
24.32	654.187	24.59341	9.91885	5.13797	24.593407	9.947595	9.89011	49.52
24.36	650.456	24.63004	9.91885	5.10867	24.630037	9.947595	9.89011	49.52
24.4	649.212	24.65934	9.91885	5.0989	24.659341	9.947595	9.89011	49.52
24.44	649.212	24.68864	9.91885	5.0989	24.688645	9.947595	9.89011	49.82
24.48	651.7	24.71062	9.91885	5.11844	24.710623	9.947595	9.89011	49.52
24.52	656.674	24.74725	9.91885	5.15751	24.747253	9.947595	9.89011	49.52
24.56	662.893	24.79121	9.91885	5.20635	24.791209	9.947595	9.89011	50.11
24.6	664.137	24.84982	9.91885	5.21612	24.849817	9.947595	9.89011	49.52
24.64	662.893	24.91575	9.91885	5.20635	24.915751	9.947595	9.89011	49.82
24.68	657.918	24.95971	9.91885	5.16728	24.959707	9.947595	9.89011	49.52
24.72	655.431	24.99634	9.91885	5.14774	24.996337	9.947595	9.89011	49.52
24.76	651.7	25.02564	9.91885	5.11844	25.025641	9.947595	9.89011	50.11
24.8	652.943	25.05495	9.91885	5.12821	25.054945	9.947595	9.89011	50.11

Appendix D: Triaxial test

24.84	655.431	25.07692	9.91885	5.14774	25.076923	9.947595	9.89011	49.82
24.88	659.162	25.0989	9.91885	5.17705	25.098901	9.947595	9.89011	49.52
24.92	664.137	25.14286	9.91885	5.21612	25.142857	9.947595	9.89011	49.52
24.96	667.868	25.19414	9.91885	5.24542	25.194139	9.947595	9.89011	49.52
25	667.868	25.26007	9.91885	5.24542	25.260073	9.947595	9.89011	49.52
25.04	664.137	25.31868	9.91885	5.21612	25.318681	9.947595	9.89011	49.52
25.08	659.162	25.36996	9.91885	5.17705	25.369963	9.947595	9.89011	49.82
25.12	656.674	25.39927	9.91885	5.15751	25.399267	9.947595	9.89011	49.82
25.16	654.187	25.42125	9.91885	5.13797	25.421245	9.947595	9.89011	49.82
25.2	654.187	25.44322	9.91885	5.13797	25.443223	9.947595	9.89011	49.82
25.24	657.918	25.4652	9.91885	5.16728	25.465201	9.947595	9.89011	49.52
25.28	664.137	25.50183	9.91885	5.21612	25.501832	9.947595	9.89011	48.94
25.32	667.868	25.53846	9.91885	5.24542	25.538462	9.947595	9.89011	49.52
25.36	674.086	25.61905	9.91885	5.29426	25.619048	9.947595	9.89011	50.4
25.4	667.868	25.67033	9.91885	5.24542	25.67033	9.947595	9.89011	50.11
25.44	664.137	25.72161	9.91885	5.21612	25.721612	9.947595	9.89011	49.82
25.48	661.649	25.75824	9.91885	5.19658	25.758242	9.947595	9.89011	50.11
25.52	660.406	25.78755	9.91885	5.18681	25.787546	9.947595	9.89011	50.11
25.56	659.162	25.8022	9.91885	5.17705	25.802198	9.947595	9.89011	50.11
25.6	661.649	25.82418	9.91885	5.19658	25.824176	9.947595	9.89011	49.82
25.64	666.624	25.86081	9.91885	5.23565	25.860806	9.947595	9.89011	49.52
25.68	670.355	25.91941	9.91885	5.26496	25.919414	9.947595	9.89011	49.52
25.72	669.111	25.94872	9.91885	5.25519	25.948718	9.947595	9.89011	48.94
25.76	670.355	26.0293	9.91885	5.26496	26.029304	9.947595	9.89011	49.82
25.8	666.624	26.07326	9.91885	5.23565	26.07326	9.947595	9.89011	49.82
25.84	664.137	26.10989	9.91885	5.21612	26.10989	9.947595	9.89011	50.11
25.88	661.649	26.13187	9.91885	5.19658	26.131868	9.947595	9.89011	49.52
25.92	661.649	26.16117	9.91885	5.19658	26.161172	9.947595	9.89011	49.82
25.96	666.624	26.19048	9.91885	5.23565	26.190476	9.947595	9.89011	50.11
26	669.111	26.22711	9.91885	5.25519	26.227106	9.947595	9.89011	49.52
26.04	671.599	26.27106	9.91885	5.27473	26.271062	9.947595	9.89011	49.52
26.08	671.599	26.337	9.91885	5.27473	26.336996	9.947595	9.89011	49.52
26.12	669.111	26.38828	9.91885	5.25519	26.388278	9.947595	9.89011	49.82
26.16	669.111	26.43956	9.91885	5.25519	26.43956	9.947595	9.89011	50.7
26.2	664.137	26.45421	9.91885	5.21612	26.454212	9.947595	9.89011	49.52
26.24	664.137	26.47619	9.91885	5.21612	26.47619	9.947595	9.89011	49.52
26.28	666.624	26.50549	9.91885	5.23565	26.505495	9.947595	9.89011	50.11
26.32	670.355	26.54212	9.91885	5.26496	26.542125	9.947595	9.89011	49.52
26.36	670.355	26.5641	9.91885	5.26496	26.564103	9.947595	9.89011	48.64
26.4	676.574	26.64469	9.91885	5.3138	26.644689	9.947595	9.89011	49.52
26.44	675.33	26.7033	9.91885	5.30403	26.703297	9.947595	9.89011	49.52
26.48	670.355	26.74725	9.91885	5.26496	26.747253	9.947595	9.89011	49.52
26.52	667.868	26.78388	9.91885	5.24542	26.783883	9.947595	9.89011	49.82
26.56	665.38	26.81319	9.91885	5.22589	26.813187	9.947595	9.89011	49.82
26.6	666.624	26.83516	9.91885	5.23565	26.835165	9.947595	9.89011	49.23
26.64	670.355	26.86447	9.91885	5.26496	26.864469	9.947595	9.89011	49.52
26.68	675.33	26.89377	9.91885	5.30403	26.893773	9.947595	9.89011	49.52
26.72	680.305	26.93773	9.91885	5.3431	26.937729	9.947595	9.89011	49.52
26.76	682.792	27.00366	9.91885	5.36264	27.003663	9.947595	9.89011	49.52
26.8	679.061	27.04762	9.91885	5.33333	27.047619	9.947595	9.89011	49.52
26.84	675.33	27.11355	9.91885	5.30403	27.113553	9.947595	9.89011	49.52
26.88	671.599	27.14286	9.91885	5.27473	27.142857	9.947595	9.89011	49.52
26.92	669.111	27.17216	9.91885	5.25519	27.172161	9.947595	9.89011	49.52
26.96	669.111	27.19414	9.91885	5.25519	27.194139	9.947595	9.89011	49.52
27	671.599	27.22344	9.91885	5.27473	27.223443	9.947595	9.89011	49.52
27.04	677.817	27.25275	9.91885	5.32357	27.252747	9.947595	9.89011	49.52
27.08	682.792	27.30403	9.91885	5.36264	27.304029	9.947595	9.89011	49.52
27.12	684.036	27.35531	9.91885	5.37241	27.355311	9.947595	9.89011	49.52
27.16	680.305	27.41392	9.91885	5.3431	27.413919	9.947595	9.89011	49.52
27.2	676.574	27.47253	9.91885	5.3138	27.472527	9.947595	9.89011	50.11
27.24	670.355	27.50183	9.91885	5.26496	27.501832	9.947595	9.89011	49.23
27.28	667.868	27.53114	9.91885	5.24542	27.531136	9.947595	9.89011	49.23
27.32	669.111	27.56044	9.91885	5.25519	27.56044	9.947595	9.89011	49.82
27.36	670.355	27.58242	9.91885	5.26496	27.582418	9.947595	9.89011	49.52
27.4	676.574	27.61172	9.91885	5.3138	27.611722	9.947595	9.89011	49.52
27.44	682.792	27.65568	9.91885	5.36264	27.655678	9.947595	9.89011	49.52
27.48	685.28	27.71429	9.91885	5.38217	27.714286	9.947595	9.89011	49.82
27.52	681.548	27.78022	9.91885	5.35287	27.78022	9.947595	9.89011	49.52
27.56	674.086	27.82418	9.91885	5.29426	27.824176	9.947595	9.89011	49.52
27.6	671.599	27.86813	9.91885	5.27473	27.868132	9.947595	9.89011	49.82
27.64	667.868	27.88278	9.91885	5.24542	27.882784	9.947595	9.89011	49.52
27.68	667.868	27.91209	9.91885	5.24542	27.912088	9.947595	9.89011	49.52
27.72	671.599	27.93407	9.91885	5.27473	27.934066	9.947595	9.89011	49.52
27.76	679.061	27.97802	9.91885	5.33333	27.978022	9.947595	9.89011	50.11
27.8	682.792	28.02198	9.91885	5.36264	28.021978	9.947595	9.89011	49.52
27.84	684.036	28.07326	9.91885	5.37241	28.07326	9.947595	9.89011	49.52
27.88	681.548	28.12454	9.91885	5.35287	28.124542	9.947595	9.89011	49.52
27.92	680.305	28.17582	9.91885	5.3431	28.175824	9.947595	9.89011	49.82
27.96	677.817	28.1978	9.91885	5.32357	28.197802	9.947595	9.89011	49.52
28	677.817	28.23443	9.91885	5.32357	28.234432	9.947595	9.89011	49.52
28.04	679.061	28.27106	9.91885	5.33333	28.271062	9.947595	9.89011	49.82
28.08	681.548	28.30037	9.91885	5.35287	28.300366	9.947595	9.89011	49.23
28.12	685.28	28.34432	9.91885	5.38217	28.344322	9.947595	9.89011	50.11
28.16	675.33	28.3663	9.91885	5.30403	28.3663	9.947595	9.89011	49.52
28.2	667.868	28.38828	9.91885	5.24542	28.388278	9.947595	9.89011	49.82
28.24	664.137	28.40293	9.91885	5.21612	28.40293	9.947595	9.89011	49.82
28.28	656.674	28.41026	9.91885	5.15751	28.410256	9.947595	9.89011	50.11
28.32	651.7	28.41026	9.91885	5.11844	28.410256	9.947595	9.89011	49.82

28.36	647.969	28.40293	9.91885	5.08913	28.40293	9.947595	9.89011	49.23
28.4	646.725	28.41026	9.91885	5.07937	28.410256	9.947595	9.89011	49.82
28.44	644.237	28.41758	9.91885	5.05983	28.417582	9.947595	9.89011	49.82
28.48	641.75	28.41758	9.91885	5.04029	28.417582	9.947595	9.89011	49.52
28.52	640.506	28.41758	9.91885	5.03053	28.417582	9.947595	9.89011	49.82
28.56	639.263	28.42491	9.91885	5.02076	28.424908	9.947595	9.89011	49.82
28.6	636.775	28.41758	9.91885	5.00122	28.417582	9.947595	9.89011	49.52
28.64	638.019	28.42491	9.91885	5.01099	28.424908	9.947595	9.89011	50.11
28.68	636.775	28.42491	9.91885	5.00122	28.424908	9.947595	9.89011	49.52
28.72	636.775	28.42491	9.91885	5.00122	28.424908	9.947595	9.89011	49.52
28.76	638.019	28.43956	9.91885	5.01099	28.43956	9.947595	9.89011	50.11
28.8	635.532	28.42491	9.91885	4.99145	28.424908	9.947595	9.89011	49.52
28.84	634.288	28.43223	9.91885	4.98168	28.432234	9.947595	9.89011	49.82
28.88	634.288	28.43223	9.91885	4.98168	28.432234	9.947595	9.89011	49.52
28.92	635.532	28.43223	9.91885	4.99145	28.432234	9.947595	9.89011	49.52
28.96	634.288	28.43956	9.91885	4.98168	28.43956	9.947595	9.89011	50.11
29	633.044	28.43223	9.91885	4.97192	28.432234	9.947595	9.89011	49.52

HCTCRB: confining pressure 100 kPa

IPC Global Universal Testing Machine

UTM_12 V2.00 Stress - Strain Test

Filename	D:\my research\Lab test Data\Triaxial\CR2GPC\UU-test no1\CR2GPC-triaxial-100kPa.B12							
Operator	Mr.Peerapong Jitsangiam							
Test type	Compression test							
Notes/Comments		CR2GPC						
Specimen shape	Cylindrical							
Specimen Information								
********************								
Identification	CR2GPC							
Core/Sample Number								
Dimensions	Point 1	Point 2	Point 3	Point 4	Point 5	Point 6	Average	Std Dev.
Diameter (mm)	100						100	
Height (mm)	100						100	
Cross-Sectional area	7853.982							
Volume	785398.2							
Comments/Properties								
Setup Parameters								
****************								
Pre-load stress (kPa)								
Pre-load load (kN)								
Pre-load hold time (s)								
Confining pressure (kPa)	100							
Confining hold time (s)	10							
Dump pressure at end of test	No							
Axial gauge length (mm)	100							
Radial gauge length (mm)								
Advanced loading control	Disabled							
Control Mode	Displacement (actuator)							
Loading Rate (mm/s)	1							
Termination Timer (sec)	0							
% Unload	0							
Minimum stress (kPa)	0							
Minimum load (kN)	0							
Termination Actuator (mm)	0							
Termination Axial (mm)	250							
Termination Radial (mm)	0							
Calibration Information								
**********************								
Channel description	Filename	Transducer description	Span	Units	Date	Linearised		
A: Axial Force	Y12346.CAR	STC5000 S/N: Y12346 +/-20kN	40	kN	7/12/2005	No		
B: Actuator LVDT	941C-340.CAR	AC-15 S/N: M992941C-340 +/-15mm	30	mm	7/12/2005	No		
C: Axial LVDT #1	83047.car	D6-05000A S/N: 83047 +/-5mm	10	mm	#######	Yes		
D: Axial LVDT #2	83048.car	D6-05000A S/N: 83048 +/-5mm	10	mm	#######	Yes		
E: Radial LVDT #1	S054041.CAR	IT2000AG S/N: S054041 +/- 600kPa	1200	kPa	#######	No		
F: Radial LVDT #2		Undefined/Not Used	1	?		No		

G: Temperature Probe		Undefined/Not Used	1	?		No		
H: Confining Pressure	S054041.CAR	IT2000AG S/N: S054041 +/- 600kPa	1200	kPa	#######	No		
Test Results								
************								
Start date and time	Monday	December 11	2006	at 11:42 AM				
Timer (sec)	29							
Peak compressive stress (kPa)	1129.3							
Peak load (kN)	8.869							
Actuator strain at peak load (%)	5.048							
Actuator deformation at peak load (mm)	5.048							
Axial av. strain at peak load (%)	4.427							
Axial av. deform. at peak load (mm)	4.427							
Time	Stress	Actuator Strain	Axial average strain	Load	Actuator	Axial LVDT #1	Axial LVDT #2	Confining Pressure
(sec)	(kPa)	(%)	(%)	(kN)	(mm)	(mm)	(mm)	(kPa)
0	1.244	0	0	0.00977	0	0	0	99.63
0.04	7.462	0.3956	0.15803	0.05861	0.395604	0.213382	0.102686	99.93
0.08	12.437	0.41758	0.17701	0.09768	0.417582	0.233114	0.120904	99.63
0.12	24.874	0.46154	0.20553	0.19536	0.461538	0.265177	0.145885	100.22
0.16	32.336	0.46154	0.22127	0.25397	0.461538	0.289841	0.152698	99.05
0.2	47.261	0.52015	0.25803	0.37118	0.520147	0.329304	0.186764	99.63
0.24	59.698	0.55678	0.2948	0.46886	0.556777	0.368767	0.22083	99.63
0.28	70.891	0.60806	0.33497	0.55678	0.608059	0.40823	0.261709	99.93
0.32	82.084	0.65934	0.3741	0.64469	0.659341	0.450159	0.298046	99.93
0.36	93.278	0.7033	0.41457	0.7326	0.703297	0.489621	0.339512	99.93
0.4	105.715	0.74725	0.45526	0.83028	0.747253	0.531551	0.378974	99.63
0.44	115.664	0.79121	0.48979	0.90842	0.791209	0.566081	0.413504	99.93
0.48	124.37	0.82051	0.51939	0.9768	0.820513	0.595678	0.443101	99.34
0.52	135.563	0.85714	0.55261	1.06471	0.857143	0.627595	0.477631	99.34
0.56	150.488	0.90842	0.59065	1.18193	0.908425	0.666667	0.514628	99.93
0.6	161.681	0.95238	0.62869	1.26984	0.952381	0.703297	0.55409	99.63
0.64	174.118	0.99634	0.663	1.36752	0.996337	0.737485	0.588523	99.93
0.68	189.043	1.03297	0.69719	1.48474	1.032967	0.771673	0.622711	99.63
0.72	202.723	1.0696	0.73016	1.59219	1.069597	0.803419	0.656899	99.93
0.76	217.648	1.10623	0.7619	1.7094	1.106227	0.835165	0.688645	99.93
0.8	235.06	1.15751	0.8022	1.84615	1.157509	0.876679	0.727717	100.51
0.84	251.228	1.19414	0.83272	1.97314	1.194139	0.908425	0.757021	99.93
0.88	264.908	1.23077	0.86447	2.08059	1.230769	0.940171	0.788767	99.34
0.92	283.564	1.2674	0.89744	2.22711	1.267399	0.974359	0.820513	99.93
0.96	299.732	1.31136	0.93407	2.35409	1.311355	1.010989	0.857143	99.63
1	317.144	1.35531	0.96947	2.49084	1.355311	1.047619	0.891331	99.93
1.04	333.312	1.38462	0.99878	2.61783	1.384615	1.076923	0.920635	99.63
1.08	350.724	1.42125	1.0317	2.75458	1.421245	1.111013	0.952381	99.93
1.12	370.623	1.47253	1.06449	2.91087	1.472527	1.14486	0.984127	99.93
1.16	385.548	1.50183	1.09364	3.02808	1.501832	1.176288	1.010989	99.34
1.2	407.934	1.55311	1.13252	3.20391	1.553114	1.214969	1.050061	100.51
1.24	425.346	1.58242	1.1605	3.34066	1.582418	1.24398	1.077021	99.63
1.28	442.758	1.61172	1.18857	3.47741	1.611722	1.272991	1.104151	99.34
1.32	463.901	1.65568	1.2252	3.64347	1.655678	1.309255	1.141148	99.63
1.36	481.313	1.69231	1.25571	3.78022	1.692308	1.340684	1.170745	99.34
1.4	499.968	1.74359	1.29358	3.92674	1.74359	1.376947	1.210208	99.93
1.44	518.624	1.78022	1.32653	4.07326	1.78022	1.410794	1.242271	99.63
1.48	536.035	1.82418	1.36072	4.21001	1.824176	1.44464	1.276801	100.22
1.52	553.447	1.85348	1.38879	4.34676	1.85348	1.473651	1.303932	99.63

1.56	568.372	1.88278	1.42043	4.46398	1.882784	1.505079	1.335775	99.34
1.6	587.027	1.91941	1.45322	4.6105	1.919414	1.538926	1.367521	99.34
1.64	604.439	1.96337	1.48846	4.74725	1.96337	1.572772	1.404151	99.93
1.68	619.363	2	1.51648	4.86447	2	1.601954	1.431013	99.63
1.72	633.044	2.03663	1.54823	4.97192	2.03663	1.6337	1.462759	99.63
1.76	647.969	2.08059	1.58486	5.08913	2.080586	1.67033	1.499389	99.93
1.8	662.893	2.11722	1.61538	5.20635	2.117216	1.704518	1.526252	99.93
1.84	676.574	2.15385	1.64713	5.3138	2.153846	1.733822	1.56044	99.93
1.88	689.011	2.18315	1.67643	5.41148	2.18315	1.763126	1.589744	99.63
1.92	701.448	2.21245	1.70818	5.50916	2.212454	1.794872	1.62149	99.93
1.96	715.128	2.24908	1.73993	5.61661	2.249084	1.82906	1.650794	99.63
2	727.565	2.28571	1.76908	5.71429	2.285714	1.858071	1.680098	99.93
2.04	740.002	2.31502	1.79946	5.81197	2.315018	1.887082	1.711844	99.93
2.08	753.683	2.35165	1.83104	5.91941	2.351648	1.920928	1.741148	99.93
2.12	764.877	2.38828	1.86263	6.00733	2.388278	1.952357	1.772894	99.93
2.16	776.07	2.42491	1.89667	6.09524	2.424908	1.986203	1.807131	99.93
2.2	793.482	2.47619	1.93209	6.23199	2.47619	2.020049	1.844127	101.1
2.24	797.213	2.47619	1.95162	6.26129	2.47619	2.039389	1.863858	98.75
2.28	812.137	2.52015	1.98705	6.37851	2.520147	2.075702	1.898388	99.34
2.32	824.574	2.5641	2.02263	6.47619	2.564103	2.112332	1.932918	99.93
2.36	837.011	2.60073	2.05453	6.57387	2.600733	2.144078	1.964982	99.93
2.4	848.205	2.63736	2.08643	6.66178	2.637363	2.175824	1.997045	99.93
2.44	858.154	2.66667	2.11957	6.73993	2.666667	2.20757	2.031575	99.93
2.48	873.079	2.72527	2.15751	6.85714	2.725275	2.246642	2.068376	100.51
2.52	878.053	2.72527	2.17949	6.89621	2.725275	2.26862	2.090354	99.34
2.56	890.49	2.77656	2.21734	6.99389	2.776557	2.30525	2.129426	99.34
2.6	901.684	2.82051	2.25519	7.08181	2.820513	2.344322	2.166056	99.93
2.64	911.633	2.85714	2.2906	7.15995	2.857143	2.380952	2.200244	99.93
2.68	921.583	2.89377	2.32601	7.2381	2.893773	2.41514	2.236874	99.93
2.72	931.533	2.93773	2.36142	7.31624	2.937729	2.45177	2.271062	99.93
2.76	941.482	2.97436	2.39573	7.39438	2.974359	2.485958	2.305495	99.93
2.8	951.432	3.01832	2.43272	7.47253	3.018315	2.522589	2.342857	100.22
2.84	958.894	3.05495	2.46357	7.53114	3.054945	2.551893	2.375238	99.93
2.88	966.356	3.08425	2.50178	7.58974	3.084249	2.590965	2.412601	99.63
2.92	975.062	3.12088	2.53878	7.65812	3.120879	2.627595	2.449963	99.93
2.96	985.012	3.16484	2.57331	7.73626	3.164835	2.661783	2.484835	99.93
3	991.23	3.19414	2.60784	7.7851	3.194139	2.695971	2.519707	99.34
3.04	998.692	3.23077	2.64353	7.84371	3.230769	2.732601	2.554457	99.34
3.08	1007.398	3.28205	2.6828	7.91209	3.282051	2.771673	2.593919	99.93
3.12	1014.861	3.31868	2.71961	7.9707	3.318681	2.808303	2.630916	99.63
3.16	1021.079	3.35531	2.7552	8.01954	3.355311	2.842491	2.667912	99.34
3.2	1028.541	3.39194	2.79447	8.07814	3.391941	2.881563	2.707375	99.34
3.24	1037.247	3.44322	2.83618	8.14652	3.443223	2.925519	2.746838	100.51
3.28	1040.978	3.47253	2.86808	8.17582	3.472527	2.957265	2.778901	99.34
3.32	1047.197	3.51648	2.91104	8.22466	3.516484	2.998779	2.823297	99.63
3.36	1052.172	3.56044	2.95153	8.26374	3.56044	3.040293	2.862759	99.63
3.4	1057.146	3.6044	2.99219	8.30281	3.604396	3.079683	2.904689	99.63
3.44	1062.121	3.64103	3.03288	8.34188	3.641026	3.121612	2.944151	99.93
3.48	1068.34	3.68498	3.07358	8.39072	3.684982	3.161074	2.986081	99.93
3.52	1070.827	3.72161	3.11551	8.41026	3.721612	3.203004	3.02801	99.93
3.56	1080.777	3.79487	3.16237	8.4884	3.794872	3.252332	3.072405	101.1
3.6	1079.533	3.8022	3.1932	8.47863	3.802198	3.281929	3.104469	99.63
3.64	1084.508	3.85348	3.23498	8.5177	3.85348	3.323565	3.146398	99.34
3.68	1086.995	3.89011	3.27303	8.53724	3.89011	3.360195	3.185861	99.63
3.72	1090.726	3.93407	3.31719	8.56654	3.934066	3.406593	3.22779	99.93

3.76	1094.457	3.9707	3.35646	8.59585	3.970696	3.445665	3.267253	99.93
3.8	1098.189	4.01465	3.39328	8.62515	4.014652	3.479853	3.306716	99.93
3.84	1098.189	4.05861	3.44359	8.62515	4.058608	3.531136	3.356044	99.63
3.88	1100.676	4.10989	3.49165	8.64469	4.10989	3.580391	3.402906	99.93
3.92	1103.163	4.15385	3.53358	8.66422	4.153846	3.619853	3.447302	99.93
3.96	1106.894	4.20513	3.58167	8.69353	4.205128	3.669182	3.494164	99.93
4	1106.894	4.23443	3.6199	8.69353	4.234432	3.708645	3.53116	99.63
4.04	1111.869	4.29304	3.6606	8.7326	4.29304	3.748107	3.573089	99.93
4.08	1111.869	4.32234	3.70005	8.7326	4.322344	3.787546	3.612552	99.93
4.12	1111.869	4.35897	3.74177	8.7326	4.358974	3.82906	3.654481	99.63
4.16	1114.357	4.41026	3.78718	8.75214	4.410256	3.873016	3.701343	99.93
4.2	1115.6	4.44689	3.82521	8.7619	4.446886	3.912088	3.738339	99.93
4.24	1118.088	4.48352	3.86325	8.78144	4.483516	3.95116	3.775336	99.63
4.28	1119.331	4.52747	3.90131	8.79121	4.527473	3.985348	3.817265	99.93
4.32	1120.575	4.5641	3.93811	8.80098	4.564103	4.02442	3.851795	99.93
4.36	1121.819	4.60073	3.97737	8.81074	4.600733	4.063492	3.891258	99.93
4.4	1124.306	4.64469	4.01786	8.83028	4.644689	4.105006	3.93072	99.63
4.44	1124.306	4.68132	4.05591	8.83028	4.681319	4.141636	3.970183	99.63
4.48	1125.55	4.7326	4.10377	8.84005	4.732601	4.188034	4.019512	99.93
4.52	1125.55	4.76923	4.14549	8.84005	4.769231	4.229548	4.061441	99.93
4.56	1126.794	4.81319	4.18722	8.84982	4.813187	4.271062	4.10337	99.93
4.6	1126.794	4.84982	4.23239	8.84982	4.849817	4.317021	4.147766	99.63
4.64	1128.037	4.90842	4.27267	8.85958	4.908425	4.35812	4.187228	100.22
4.68	1128.037	4.94505	4.3191	8.85958	4.945055	4.401636	4.236557	99.93
4.72	1128.037	4.98901	4.36298	8.85958	4.989011	4.44757	4.278388	99.63
4.76	1125.55	5.01099	4.40187	8.84005	5.010989	4.483834	4.319902	99.05
4.8	1128.037	5.0696	4.44696	8.85958	5.069597	4.530061	4.363858	99.63
4.84	1129.281	5.11355	4.48746	8.86935	5.113553	4.57199	4.40293	99.93
4.88	1128.037	5.14286	4.52426	8.85958	5.142857	4.60652	4.442002	99.34
4.92	1129.281	5.19414	4.57335	8.86935	5.194139	4.655849	4.490842	99.93
4.96	1129.281	5.24542	4.62256	8.86935	5.245421	4.705177	4.539951	99.93
5	1128.037	5.28938	4.66696	8.85958	5.289377	4.749573	4.584347	99.63
5.04	1125.55	5.31868	4.70602	8.84005	5.318681	4.78823	4.62381	99.34
5.08	1126.794	5.37729	4.75705	8.84982	5.377289	4.838486	4.675604	99.93
5.12	1125.55	5.42857	4.80441	8.84005	5.428571	4.886349	4.722466	99.93
5.16	1124.306	5.47985	4.85769	8.83028	5.479853	4.938999	4.776386	99.93
5.2	1120.575	5.52381	4.90339	8.80098	5.52381	4.984469	4.82232	99.63
5.24	1119.331	5.56777	4.95089	8.79121	5.567766	5.031111	4.870672	99.63
5.28	1115.6	5.61905	5.00243	8.7619	5.619048	5.083419	4.921441	99.93
5.32	1113.113	5.65568	5.04536	8.74237	5.655678	5.125763	4.964957	99.34
5.36	1111.869	5.70696	5.09089	8.7326	5.70696	5.173089	5.008694	99.63
5.4	1109.382	5.75092	5.13448	8.71306	5.750916	5.215433	5.053529	99.93
5.44	1106.894	5.78755	5.17057	8.69353	5.787546	5.252747	5.0884	99.93
5.48	1101.92	5.8022	5.20142	8.65446	5.802198	5.282051	5.120781	99.05
5.52	1101.92	5.84615	5.24088	8.65446	5.846154	5.321123	5.160635	99.63
5.56	1104.407	5.89011	5.27663	8.67399	5.89011	5.357753	5.195507	99.63
5.6	1105.651	5.93407	5.31487	8.68376	5.934066	5.394383	5.23536	100.22
5.64	1104.407	5.96337	5.3564	8.67399	5.96337	5.435897	5.276899	99.93
5.68	1103.163	6.01465	5.40013	8.66422	6.014652	5.479853	5.320415	99.93
5.72	1100.676	6.05861	5.45237	8.64469	6.058608	5.531136	5.373602	99.63
5.76	1096.945	6.10989	5.50582	8.61538	6.10989	5.58486	5.426789	99.63
5.8	1090.726	6.16117	5.55806	8.56654	6.161172	5.636142	5.479976	99.93
5.84	1086.995	6.21245	5.60824	8.53724	6.212454	5.687424	5.52906	100.22
5.88	1078.289	6.25641	5.65733	8.46886	6.25641	5.736264	5.578388	99.93
5.92	1070.827	6.30769	5.70763	8.41026	6.307692	5.787546	5.627717	99.93

5.96	1065.852	6.35165	5.74813	8.37118	6.351648	5.826618	5.669646	99.93
6	1058.39	6.35897	5.77882	8.31258	6.358974	5.855922	5.701709	99.34
6.04	1057.146	6.41026	5.81194	8.30281	6.410256	5.89011	5.733773	99.63
6.08	1054.659	6.43956	5.84114	8.28327	6.43956	5.916972	5.765299	99.93
6.12	1058.39	6.48352	5.87759	8.31258	6.483516	5.956044	5.799145	101.39
6.16	1054.659	6.49084	5.89217	8.28327	6.490842	5.970696	5.813651	99.93
6.2	1054.659	6.51282	5.92016	8.28327	6.512821	5.995238	5.845079	99.93
6.24	1058.39	6.55678	5.95314	8.31258	6.556777	6.029768	5.876508	99.63
6.28	1059.634	6.58608	5.98979	8.32234	6.586081	6.069231	5.910354	99.63
6.32	1060.877	6.63736	6.03984	8.33211	6.637363	6.118559	5.961123	99.93
6.36	1060.877	6.69597	6.09761	8.33211	6.695971	6.175287	6.019927	99.93
6.4	1057.146	6.74725	6.15187	8.30281	6.747253	6.229548	6.074188	99.63
6.44	1052.172	6.79853	6.20586	8.26374	6.798535	6.283272	6.128449	99.63
6.48	1047.197	6.84249	6.25496	8.22466	6.842491	6.32967	6.180244	99.93
6.52	1042.222	6.87912	6.29299	8.18559	6.879121	6.368742	6.217241	99.63
6.56	1038.491	6.91575	6.32954	8.15629	6.915751	6.405372	6.2537	99.63
6.6	1036.003	6.94505	6.36355	8.13675	6.945055	6.43956	6.287546	99.93
6.64	1034.76	6.98168	6.39027	8.12698	6.981685	6.46398	6.316557	99.93
6.68	1032.272	7.00366	6.41587	8.10745	7.003663	6.491013	6.340733	99.63
6.72	1033.516	7.03297	6.44762	8.11722	7.032967	6.523077	6.372161	99.93
6.76	1034.76	7.0696	6.48302	8.12698	7.069597	6.557607	6.408425	99.93
6.8	1036.003	7.10623	6.52209	8.13675	7.106227	6.59707	6.447106	99.93
6.84	1037.247	7.15751	6.57106	8.14652	7.157509	6.646398	6.495726	99.93
6.88	1036.003	7.20879	6.62505	8.13675	7.208791	6.700659	6.549451	99.93
6.92	1032.272	7.26007	6.67521	8.10745	7.260073	6.752137	6.598291	99.93
6.96	1028.541	7.30403	6.72527	8.07814	7.304029	6.800977	6.649573	99.63
7	1026.054	7.36264	6.77411	8.05861	7.362637	6.849817	6.698413	100.22
7.04	1021.079	7.39194	6.80952	8.01954	7.391941	6.884005	6.735043	99.63
7.08	1018.592	7.42857	6.84493	8	7.428571	6.920635	6.769231	99.63
7.12	1016.104	7.45788	6.8779	7.98046	7.457875	6.952381	6.803419	99.93
7.16	1014.861	7.50183	6.9122	7.9707	7.501832	6.986789	6.837607	100.22
7.2	1012.373	7.51648	6.93674	7.95116	7.516484	7.011453	6.862027	99.93
7.24	1014.861	7.54579	6.96864	7.9707	7.545788	7.043516	6.893773	99.93
7.28	1017.348	7.58242	6.99932	7.99023	7.582418	7.073114	6.925519	99.93
7.32	1017.348	7.59707	7.03366	7.99023	7.59707	7.107643	6.959683	99.34
7.36	1022.323	7.67033	7.08618	8.0293	7.67033	7.161905	7.010452	99.93
7.4	1022.323	7.71429	7.13623	8.0293	7.714286	7.211233	7.061221	99.93
7.44	1019.835	7.77289	7.19425	8.00977	7.772894	7.269255	7.119243	99.63
7.48	1014.861	7.82418	7.25227	7.9707	7.824176	7.327277	7.177265	99.93
7.52	1008.642	7.87546	7.30667	7.92186	7.875458	7.380464	7.232869	99.34
7.56	1001.18	7.91941	7.35381	7.86325	7.919414	7.426398	7.281221	99.05
7.6	994.961	7.96337	7.3975	7.81441	7.96337	7.470256	7.324737	99.34
7.64	987.499	8.00733	7.44513	7.7558	8.007326	7.519585	7.370672	99.34
7.68	981.281	8.04396	7.4842	7.70696	8.043956	7.559048	7.409353	99.34
7.72	980.037	8.10256	7.52204	7.69719	8.102564	7.596044	7.448034	100.51
7.76	975.062	8.10256	7.54034	7.65812	8.102564	7.613309	7.467375	99.93
7.8	972.575	8.12454	7.56476	7.63858	8.124542	7.637973	7.491551	99.93
7.84	972.575	8.14652	7.5843	7.63858	8.14652	7.657705	7.510891	99.93
7.88	977.549	8.17582	7.60751	7.67766	8.175824	7.682369	7.53265	100.22
7.92	981.281	8.1978	7.63306	7.70696	8.197802	7.706886	7.559243	99.63
7.96	986.255	8.23443	7.67054	7.74603	8.234432	7.74315	7.597924	99.93
8	988.743	8.28571	7.7201	7.76557	8.285714	7.793919	7.646276	99.93
8.04	987.499	8.35897	7.78521	7.7558	8.358974	7.856777	7.713651	99.93
8.08	982.524	8.42491	7.86098	7.71673	8.424908	7.931722	7.790232	99.93
8.12	975.062	8.48352	7.92043	7.65812	8.483516	7.993187	7.847668	99.63

8.16	967.6	8.52747	7.97022	7.59951	8.527473	8.042515	7.897924	99.63
8.2	962.625	8.57143	8.01284	7.56044	8.571429	8.086911	7.938779	99.93
8.24	957.65	8.60073	8.04457	7.52137	8.600733	8.116508	7.972625	99.93
8.28	957.65	8.64469	8.07266	7.52137	8.644689	8.146105	7.999219	100.81
8.32	952.675	8.64469	8.08852	7.4823	8.644689	8.160904	8.016142	99.93
8.36	952.675	8.66667	8.10806	7.4823	8.666667	8.180635	8.035482	99.63
8.4	956.407	8.68132	8.12753	7.5116	8.681319	8.200244	8.054823	99.63
8.44	961.381	8.71062	8.15669	7.55067	8.710623	8.229548	8.083834	99.63
8.48	967.6	8.75458	8.19557	7.59951	8.754579	8.26862	8.122515	99.93
8.52	970.087	8.79853	8.2441	7.61905	8.798535	8.315018	8.173187	99.63
8.56	971.331	8.86447	8.30696	7.62882	8.864469	8.37851	8.235409	99.93
8.6	965.112	8.93773	8.38674	7.57998	8.937729	8.459096	8.314383	99.63
8.64	952.675	9.03297	8.48348	7.4823	9.032967	8.556777	8.410183	99.93
8.68	941.482	9.09158	8.543	7.39438	9.091575	8.615385	8.470623	99.63
8.72	932.776	9.12821	8.58309	7.32601	9.128205	8.654457	8.511722	99.93
8.76	926.558	9.15751	8.6098	7.27717	9.157509	8.678877	8.540733	99.93
8.8	921.583	9.17216	8.62805	7.2381	9.172161	8.700855	8.555238	99.63
8.84	919.096	9.18681	8.6414	7.21856	9.186813	8.713065	8.569744	99.93
8.88	917.852	9.18681	8.65233	7.20879	9.186813	8.722833	8.581832	99.34
8.92	922.827	9.21612	8.66691	7.24786	9.216117	8.737485	8.596337	99.63
8.96	927.801	9.23077	8.68514	7.28694	9.230769	8.757021	8.61326	99.93
9	937.751	9.26007	8.70822	7.36508	9.260073	8.778999	8.637436	99.93
9.04	950.188	9.31136	8.74694	7.46276	9.311355	8.818071	8.6758	101.1
9.08	953.919	9.34799	8.79407	7.49206	9.347985	8.864469	8.723663	99.93
9.12	951.432	9.42125	8.87397	7.47253	9.421245	8.945299	8.802637	99.93
9.16	945.213	9.50183	8.95779	7.42369	9.501832	9.029158	8.886422	99.93
9.2	936.507	9.56777	9.02493	7.35531	9.567766	9.095751	8.954115	99.93
9.24	929.045	9.61172	9.07254	7.2967	9.611722	9.142613	9.002466	99.93
9.28	922.827	9.64835	9.10425	7.24786	9.648352	9.174603	9.033895	99.63
9.32	919.096	9.67766	9.13219	7.21856	9.677656	9.201465	9.062906	99.93
9.36	916.608	9.69231	9.15162	7.19902	9.692308	9.221001	9.082247	99.34
9.4	919.096	9.72894	9.17349	7.21856	9.728938	9.242979	9.104005	100.51
9.44	919.096	9.72894	9.18929	7.21856	9.728938	9.260073	9.11851	99.93
9.48	922.827	9.75092	9.20994	7.24786	9.750916	9.279609	9.140269	99.63
9.52	927.801	9.78022	9.23788	7.28694	9.78022	9.306471	9.16928	99.93
9.56	935.264	9.82418	9.27796	7.34554	9.824176	9.345543	9.210379	99.93
9.6	935.264	9.86081	9.329	7.34554	9.860806	9.399267	9.25873	99.34
9.64	936.507	9.94872	9.40363	7.35531	9.948718	9.47116	9.336093	99.93
9.68	930.289	10.0293	9.48049	7.30647	10.0293	9.544615	9.416361	99.93
9.72	921.583	10.08791	9.53978	7.2381	10.08791	9.599707	9.479853	99.63
9.76	915.364	10.13187	9.58364	7.18926	10.13187	9.641026	9.526252	99.63
9.8	911.633	10.17582	9.62027	7.15995	10.17582	9.677656	9.562882	100.51
9.84	907.902	10.1978	9.64713	7.13065	10.1978	9.704518	9.589744	100.81
9.88	902.927	10.21245	9.66545	7.09158	10.21245	9.721612	9.60928	99.93
9.92	901.684	10.24176	9.69173	7.08181	10.24176	9.746032	9.637436	99.93
9.96	901.684	10.26374	9.72088	7.08181	10.26374	9.772894	9.668864	99.93
10	902.927	10.28571	9.74473	7.09158	10.28571	9.794872	9.694579	99.93
10.04	901.684	10.29304	9.76592	7.08181	10.29304	9.814408	9.717436	98.75
10.08	910.39	10.34432	9.80832	7.15018	10.34432	9.85348	9.76315	99.93
10.12	914.121	10.40293	9.86416	7.17949	10.40293	9.90232	9.826007	99.93
10.16	914.121	10.46154	9.93156	7.17949	10.46154	9.96337	9.899756	99.93
10.2	910.39	10.52747	9.98004	7.15018	10.52747	10	9.960073	99.93
10.24	905.415	10.57875	10.00324	7.11111	10.57876	10	10.00647	99.63
10.28	901.684	10.63004	10.00324	7.08181	10.63004	10	10.00647	99.93
10.32	899.196	10.65934	10.00324	7.06227	10.65934	10	10.00647	99.63

10.36	894.221	10.69597	10.00324	7.0232	10.69597	10	10.00647	99.63
10.4	889.247	10.69597	10.00324	6.98413	10.69597	10	10.00647	98.75
10.44	894.221	10.7326	10.00324	7.0232	10.7326	10	10.00647	99.63
10.48	897.953	10.7619	10.00324	7.0525	10.76191	10	10.00647	99.93
10.52	901.684	10.79121	10.00324	7.08181	10.79121	10	10.00647	99.93
10.56	905.415	10.83516	10.00324	7.11111	10.83517	10	10.00647	99.93
10.6	909.146	10.89377	10.00324	7.14042	10.89377	10	10.00647	100.22
10.64	907.902	10.95238	10.00324	7.13065	10.95238	10	10.00647	100.51
10.68	906.658	11.01832	10.00324	7.12088	11.01832	10	10.00647	100.51
10.72	900.44	11.06227	10.00324	7.07204	11.06227	10	10.00647	99.93
10.76	895.465	11.0989	10.00324	7.03297	11.0989	10	10.00647	99.93
10.8	892.978	11.15018	10.00324	7.01343	11.15018	10	10.00647	100.22
10.84	888.003	11.17216	10.00324	6.97436	11.17216	10	10.00647	99.63
10.88	885.516	11.20147	10.00324	6.95482	11.20147	10	10.00647	99.93
10.92	884.272	11.23077	10.00324	6.94505	11.23077	10	10.00647	99.93
10.96	883.028	11.25275	10.00324	6.93529	11.25275	10	10.00647	99.63
11	886.759	11.28205	10.00324	6.96459	11.28205	10	10.00647	99.93
11.04	890.49	11.31136	10.00324	6.99389	11.31136	10	10.00647	99.34
11.08	891.734	11.32601	10.00324	7.00366	11.32601	10	10.00647	99.34
11.12	897.953	11.39194	10.00324	7.0525	11.39194	10	10.00647	100.22
11.16	901.684	11.4652	10.00324	7.08181	11.4652	10	10.00647	100.51
11.2	900.44	11.50916	10.00324	7.07204	11.50916	10	10.00647	99.93
11.24	896.709	11.56044	10.00324	7.04274	11.56044	10	10.00647	99.93
11.28	892.978	11.61905	10.00324	7.01343	11.61905	10	10.00647	99.93
11.32	889.247	11.65568	10.00324	6.98413	11.65568	10	10.00647	99.93
11.36	885.516	11.69963	10.00324	6.95482	11.69963	10	10.00647	99.63
11.4	881.784	11.72894	10.00324	6.92552	11.72894	10	10.00647	99.34
11.44	880.541	11.75824	10.00324	6.91575	11.75824	10	10.00647	99.93
11.48	879.297	11.78022	10.00324	6.90598	11.78022	10	10.00647	99.93
11.52	879.297	11.80952	10.00324	6.90598	11.80952	10	10.00647	99.93
11.56	881.784	11.83883	10.00324	6.92552	11.83883	10	10.00647	99.93
11.6	885.516	11.86813	10.00324	6.95482	11.86813	10	10.00647	99.93
11.64	890.49	11.91209	10.00324	6.99389	11.91209	10	10.00647	99.93
11.68	891.734	11.95604	10.00324	7.00366	11.95604	10	10.00647	99.93
11.72	890.49	12.00733	10.00324	6.99389	12.00733	10	10.00647	99.05
11.76	885.516	12.07326	10.00324	6.95482	12.07326	10	10.00647	99.34
11.8	884.272	12.14652	10.00324	6.94505	12.14652	10	10.00647	99.93
11.84	873.079	12.14652	10.00324	6.85714	12.14652	10	10.00647	98.17
11.88	874.322	12.21245	10.00324	6.86691	12.21245	10	10.00647	99.05
11.92	870.591	12.24176	10.00324	6.83761	12.24176	10	10.00647	99.63
11.96	870.591	12.27106	10.00324	6.83761	12.27106	10	10.00647	99.63
12	870.591	12.30037	10.00324	6.83761	12.30037	10	10.00647	99.93
12.04	871.835	12.32234	10.00324	6.84737	12.32234	10	10.00647	99.93
12.08	874.322	12.35165	10.00324	6.86691	12.35165	10	10.00647	99.93
12.12	878.053	12.3956	10.00324	6.89621	12.3956	10	10.00647	99.93
12.16	879.297	12.44689	10.00324	6.90598	12.44689	10	10.00647	99.93
12.2	876.81	12.50549	10.00324	6.88645	12.5055	10	10.00647	99.93
12.24	873.079	12.57143	10.00324	6.85714	12.57143	10	10.00647	99.93
12.28	866.86	12.63004	10.00324	6.8083	12.63004	10	10.00647	99.93
12.32	861.885	12.66667	10.00324	6.76923	12.66667	10	10.00647	99.63
12.36	856.91	12.68864	10.00324	6.73016	12.68865	10	10.00647	99.34
12.4	855.667	12.72527	10.00324	6.72039	12.72528	10	10.00647	99.63
12.44	854.423	12.74725	10.00324	6.71062	12.74725	10	10.00647	99.63
12.48	854.423	12.7619	10.00324	6.71062	12.76191	10	10.00647	99.34
12.52	858.154	12.79121	10.00324	6.73993	12.79121	10	10.00647	99.93

12.56	864.373	12.81319	10.00324	6.78877	12.81319	10	10.00647	99.93
12.6	868.104	12.84249	10.00324	6.81807	12.84249	10	10.00647	99.34
12.64	871.835	12.90842	10.00324	6.84737	12.90843	10	10.00647	99.93
12.68	871.835	12.97436	10.00324	6.84737	12.97436	10	10.00647	99.93
12.72	869.347	13.03297	10.00324	6.82784	13.03297	10	10.00647	99.93
12.76	866.86	13.07692	10.00324	6.8083	13.07692	10	10.00647	99.93
12.8	865.616	13.11355	10.00324	6.79853	13.11355	10	10.00647	99.93
12.84	864.373	13.15018	10.00324	6.78877	13.15018	10	10.00647	99.93
12.88	863.129	13.17949	10.00324	6.779	13.17949	10	10.00647	99.63
12.92	864.373	13.20147	10.00324	6.78877	13.20147	10	10.00647	99.34
12.96	868.104	13.2381	10.00324	6.81807	13.2381	10	10.00647	99.93
13	871.835	13.27473	10.00324	6.84737	13.27473	10	10.00647	99.93
13.04	874.322	13.31868	10.00324	6.86691	13.31868	10	10.00647	99.63
13.08	875.566	13.37729	10.00324	6.87668	13.37729	10	10.00647	99.93
13.12	874.322	13.4359	10.00324	6.86691	13.4359	10	10.00647	99.63
13.16	870.591	13.49451	10.00324	6.83761	13.49451	10	10.00647	99.93
13.2	866.86	13.53846	10.00324	6.8083	13.53846	10	10.00647	99.93
13.24	861.885	13.57509	10.00324	6.76923	13.57509	10	10.00647	99.93
13.28	860.642	13.59707	10.00324	6.75946	13.59707	10	10.00647	99.93
13.32	859.398	13.62637	10.00324	6.74969	13.62637	10	10.00647	99.93
13.36	863.129	13.663	10.00324	6.779	13.663	10	10.00647	101.1
13.4	864.373	13.68498	10.00324	6.78877	13.68498	10	10.00647	100.51
13.44	861.885	13.69231	10.00324	6.76923	13.69231	10	10.00647	98.75
13.48	868.104	13.74359	10.00324	6.81807	13.74359	10	10.00647	99.34
13.52	871.835	13.79487	10.00324	6.84737	13.79487	10	10.00647	99.93
13.56	871.835	13.86081	10.00324	6.84737	13.86081	10	10.00647	99.63
13.6	866.86	13.91941	10.00324	6.8083	13.91941	10	10.00647	99.63
13.64	863.129	13.97802	10.00324	6.779	13.97802	10	10.00647	99.63
13.68	858.154	14.0293	10.00324	6.73993	14.0293	10	10.00647	99.93
13.72	854.423	14.05861	10.00324	6.71062	14.05861	10	10.00647	99.93
13.76	851.936	14.08791	10.00324	6.69109	14.08791	10	10.00647	99.93
13.8	849.448	14.10256	10.00324	6.67155	14.10256	10	10.00647	99.34
13.84	851.936	14.13187	10.00324	6.69109	14.13187	10	10.00647	99.93
13.88	853.179	14.15385	10.00324	6.70085	14.15385	10	10.00647	99.63
13.92	858.154	14.18315	10.00324	6.73993	14.18315	10	10.00647	99.63
13.96	863.129	14.21978	10.00324	6.779	14.21978	10	10.00647	99.93
14	866.86	14.27106	10.00324	6.8083	14.27106	10	10.00647	99.93
14.04	868.104	14.32967	10.00324	6.81807	14.32967	10	10.00647	99.34
14.08	866.86	14.3956	10.00324	6.8083	14.3956	10	10.00647	99.93
14.12	863.129	14.46154	10.00324	6.779	14.46154	10	10.00647	99.63
14.16	858.154	14.50549	10.00324	6.73993	14.5055	10	10.00647	99.93
14.2	849.448	14.52015	10.00324	6.67155	14.52015	10	10.00647	98.75
14.24	848.205	14.55678	10.00324	6.66178	14.55678	10	10.00647	99.34
14.28	846.961	14.57875	10.00324	6.65201	14.57876	10	10.00647	98.75
14.32	850.692	14.62271	10.00324	6.68132	14.62271	10	10.00647	100.22
14.36	850.692	14.63736	10.00324	6.68132	14.63736	10	10.00647	99.63
14.4	854.423	14.65934	10.00324	6.71062	14.65934	10	10.00647	99.63
14.44	858.154	14.68864	10.00324	6.73993	14.68865	10	10.00647	99.05
14.48	868.104	14.75458	10.00324	6.81807	14.75458	10	10.00647	100.51
14.52	868.104	14.79121	10.00324	6.81807	14.79121	10	10.00647	99.93
14.56	869.347	14.86447	10.00324	6.82784	14.86447	10	10.00647	99.93
14.6	866.86	14.91575	10.00324	6.8083	14.91575	10	10.00647	99.63
14.64	863.129	14.97436	10.00324	6.779	14.97436	10	10.00647	99.63
14.68	858.154	15.01832	10.00324	6.73993	15.01832	10	10.00647	99.93
14.72	855.667	15.06227	10.00324	6.72039	15.06227	10	10.00647	99.93

14.76	851.936	15.08425	10.00324	6.69109	15.08425	10	10.00647	99.93
14.8	849.448	15.10623	10.00324	6.67155	15.10623	10	10.00647	99.34
14.84	850.692	15.13553	10.00324	6.68132	15.13553	10	10.00647	99.93
14.88	850.692	15.15018	10.00324	6.68132	15.15018	10	10.00647	99.93
14.92	854.423	15.18681	10.00324	6.71062	15.18681	10	10.00647	99.93
14.96	858.154	15.21612	10.00324	6.73993	15.21612	10	10.00647	99.93
15	861.885	15.26007	10.00324	6.76923	15.26007	10	10.00647	99.63
15.04	861.885	15.32601	10.00324	6.76923	15.32601	10	10.00647	99.93
15.08	860.642	15.39927	10.00324	6.75946	15.39927	10	10.00647	99.93
15.12	853.179	15.4652	10.00324	6.70085	15.4652	10	10.00647	99.93
15.16	846.961	15.51648	10.00324	6.65201	15.51648	10	10.00647	99.63
15.2	841.986	15.54579	10.00324	6.61294	15.54579	10	10.00647	99.63
15.24	835.767	15.56044	10.00324	6.5641	15.56044	10	10.00647	99.34
15.28	834.524	15.59707	10.00324	6.55433	15.59707	10	10.00647	99.63
15.32	834.524	15.61172	10.00324	6.55433	15.61172	10	10.00647	99.63
15.36	835.767	15.6337	10.00324	6.5641	15.6337	10	10.00647	99.63
15.4	839.499	15.65568	10.00324	6.59341	15.65568	10	10.00647	99.63
15.44	845.717	15.69231	10.00324	6.64225	15.69231	10	10.00647	100.22
15.48	850.692	15.72161	10.00324	6.68132	15.72161	10	10.00647	99.93
15.52	854.423	15.78022	10.00324	6.71062	15.78022	10	10.00647	99.93
15.56	850.692	15.85348	10.00324	6.68132	15.85348	10	10.00647	99.63
15.6	844.473	15.94139	10.00324	6.63248	15.94139	10	10.00647	99.34
15.64	837.011	16	10.00324	6.57387	16	10	10.00647	99.93
15.68	828.305	16.05128	10.00324	6.50549	16.05128	10	10.00647	99.93
15.72	823.33	16.08059	10.00324	6.46642	16.08059	10	10.00647	99.63
15.76	819.599	16.10256	10.00324	6.43712	16.10256	10	10.00647	99.93
15.8	815.868	16.11722	10.00324	6.40781	16.11722	10	10.00647	99.93
15.84	818.356	16.15385	10.00324	6.42735	16.15385	10	10.00647	100.22
15.88	817.112	16.14652	10.00324	6.41758	16.14652	10	10.00647	99.63
15.92	818.356	16.15385	10.00324	6.42735	16.15385	10	10.00647	99.34
15.96	828.305	16.1978	10.00324	6.50549	16.1978	10	10.00647	100.22
16	834.524	16.21978	10.00324	6.55433	16.21978	10	10.00647	99.93
16.04	838.255	16.24908	10.00324	6.58364	16.24908	10	10.00647	98.75
16.08	845.717	16.35897	10.00324	6.64225	16.35897	10	10.00647	100.51
16.12	837.011	16.43956	10.00324	6.57387	16.43956	10	10.00647	99.93
16.16	829.549	16.51282	10.00324	6.51526	16.51282	10	10.00647	100.22
16.2	822.087	16.57143	10.00324	6.45665	16.57143	10	10.00647	99.93
16.24	815.868	16.59341	10.00324	6.40781	16.59341	10	10.00647	99.63
16.28	809.65	16.61538	10.00324	6.35897	16.61539	10	10.00647	99.34
16.32	807.162	16.63004	10.00324	6.33944	16.63004	10	10.00647	99.34
16.36	805.919	16.65201	10.00324	6.32967	16.65202	10	10.00647	99.63
16.4	807.162	16.66667	10.00324	6.33944	16.66667	10	10.00647	99.63
16.44	810.893	16.68864	10.00324	6.36874	16.68865	10	10.00647	99.63
16.48	818.356	16.71062	10.00324	6.42735	16.71062	10	10.00647	99.93
16.52	827.062	16.73993	10.00324	6.49573	16.73993	10	10.00647	100.22
16.56	833.28	16.79121	10.00324	6.54457	16.79121	10	10.00647	99.93
16.6	833.28	16.84249	10.00324	6.54457	16.84249	10	10.00647	99.05
16.64	828.305	16.92308	10.00324	6.50549	16.92308	10	10.00647	99.05
16.68	825.818	17.01832	10.00324	6.48596	17.01832	10	10.00647	99.93
16.72	817.112	17.0696	10.00324	6.41758	17.0696	10	10.00647	99.93
16.76	810.893	17.0989	10.00324	6.36874	17.0989	10	10.00647	99.93
16.8	807.162	17.12821	10.00324	6.33944	17.12821	10	10.00647	99.63
16.84	804.675	17.14286	10.00324	6.3199	17.14286	10	10.00647	99.34
16.88	804.675	17.16484	10.00324	6.3199	17.16484	10	10.00647	99.93
16.92	804.675	17.17949	10.00324	6.3199	17.17949	10	10.00647	99.34

16.96	808.406	17.20147	10.00324	6.34921	17.20147	10	10.00647	99.63
17	815.868	17.23077	10.00324	6.40781	17.23077	10	10.00647	99.63
17.04	822.087	17.2674	10.00324	6.45665	17.2674	10	10.00647	99.93
17.08	827.062	17.31868	10.00324	6.49573	17.31868	10	10.00647	99.93
17.12	829.549	17.38462	10.00324	6.51526	17.38462	10	10.00647	99.93
17.16	827.062	17.45055	10.00324	6.49573	17.45055	10	10.00647	99.93
17.2	824.574	17.52381	10.00324	6.47619	17.52381	10	10.00647	100.51
17.24	817.112	17.56777	10.00324	6.41758	17.56777	10	10.00647	99.93
17.28	810.893	17.61172	10.00324	6.36874	17.61172	10	10.00647	99.63
17.32	807.162	17.64835	10.00324	6.33944	17.64835	10	10.00647	99.93
17.36	803.431	17.67033	10.00324	6.31013	17.67033	10	10.00647	99.63
17.4	800.944	17.69231	10.00324	6.2906	17.69231	10	10.00647	99.34
17.44	802.188	17.71429	10.00324	6.30037	17.71429	10	10.00647	99.93
17.48	802.188	17.72894	10.00324	6.30037	17.72894	10	10.00647	99.34
17.52	807.162	17.75824	10.00324	6.33944	17.75824	10	10.00647	99.93
17.56	812.137	17.78755	10.00324	6.37851	17.78755	10	10.00647	99.63
17.6	817.112	17.8315	10.00324	6.41758	17.8315	10	10.00647	99.63
17.64	818.356	17.89744	10.00324	6.42735	17.89744	10	10.00647	99.93
17.68	818.356	17.96337	10.00324	6.42735	17.96337	10	10.00647	99.93
17.72	813.381	18.0293	10.00324	6.38828	18.0293	10	10.00647	99.93
17.76	809.65	18.08059	10.00324	6.35897	18.08059	10	10.00647	99.93
17.8	805.919	18.11722	10.00324	6.32967	18.11722	10	10.00647	99.93
17.84	802.188	18.14652	10.00324	6.30037	18.14652	10	10.00647	99.63
17.88	799.7	18.1685	10.00324	6.28083	18.1685	10	10.00647	99.63
17.92	803.431	18.21978	10.00324	6.31013	18.21978	10	10.00647	100.81
17.96	799.7	18.21978	10.00324	6.28083	18.21978	10	10.00647	99.93
18	802.188	18.24908	10.00324	6.30037	18.24908	10	10.00647	99.93
18.04	807.162	18.28571	10.00324	6.33944	18.28571	10	10.00647	99.63
18.08	809.65	18.32234	10.00324	6.35897	18.32234	10	10.00647	99.63
18.12	813.381	18.38095	10.00324	6.38828	18.38095	10	10.00647	99.93
18.16	812.137	18.44689	10.00324	6.37851	18.44689	10	10.00647	99.93
18.2	807.162	18.50549	10.00324	6.33944	18.5055	10	10.00647	99.93
18.24	802.188	18.5641	10.00324	6.30037	18.5641	10	10.00647	99.93
18.28	797.213	18.60073	10.00324	6.26129	18.60073	10	10.00647	99.93
18.32	793.482	18.63004	10.00324	6.23199	18.63004	10	10.00647	99.93
18.36	786.019	18.63004	10.00324	6.17338	18.63004	10	10.00647	98.75
18.4	789.751	18.68132	10.00324	6.20269	18.68132	10	10.00647	99.93
18.44	792.238	18.71062	10.00324	6.22222	18.71062	10	10.00647	100.51
18.48	792.238	18.72527	10.00324	6.22222	18.72528	10	10.00647	99.34
18.52	795.969	18.7619	10.00324	6.25153	18.76191	10	10.00647	99.63
18.56	798.456	18.79853	10.00324	6.27106	18.79854	10	10.00647	99.93
18.6	802.188	18.84982	10.00324	6.30037	18.84982	10	10.00647	99.93
18.64	802.188	18.91575	10.00324	6.30037	18.91575	10	10.00647	99.93
18.68	799.7	18.96703	10.00324	6.28083	18.96703	10	10.00647	99.93
18.72	795.969	19.01832	10.00324	6.25153	19.01832	10	10.00647	99.63
18.76	792.238	19.0696	10.00324	6.22222	19.0696	10	10.00647	99.63
18.8	789.751	19.10623	10.00324	6.20269	19.10623	10	10.00647	99.93
18.84	784.776	19.12821	10.00324	6.16361	19.12821	10	10.00647	99.93
18.88	784.776	19.16484	10.00324	6.16361	19.16484	10	10.00647	99.93
18.92	782.288	19.18681	10.00324	6.14408	19.18681	10	10.00647	99.93
18.96	783.532	19.20879	10.00324	6.15385	19.20879	10	10.00647	99.93
19	789.751	19.26007	10.00324	6.20269	19.26007	10	10.00647	101.1
19.04	789.751	19.27473	10.00324	6.20269	19.27473	10	10.00647	99.63
19.08	792.238	19.31868	10.00324	6.22222	19.31868	10	10.00647	99.93
19.12	789.751	19.35531	10.00324	6.20269	19.35531	10	10.00647	98.75

19.16	792.238	19.44322	10.00324	6.22222	19.44322	10	10.00647	99.63
19.2	789.751	19.50183	10.00324	6.20269	19.50183	10	10.00647	99.93
19.24	786.019	19.53846	10.00324	6.17338	19.53846	10	10.00647	99.93
19.28	782.288	19.58242	10.00324	6.14408	19.58242	10	10.00647	99.93
19.32	779.801	19.61172	10.00324	6.12454	19.61172	10	10.00647	99.93
19.36	777.314	19.64835	10.00324	6.10501	19.64835	10	10.00647	99.93
19.4	776.07	19.663	10.00324	6.09524	19.663	10	10.00647	99.63
19.44	776.07	19.69231	10.00324	6.09524	19.69231	10	10.00647	99.93
19.48	778.557	19.72894	10.00324	6.11477	19.72894	10	10.00647	99.93
19.52	781.045	19.75824	10.00324	6.13431	19.75824	10	10.00647	99.63
19.56	786.019	19.80952	10.00324	6.17338	19.80952	10	10.00647	99.93
19.6	786.019	19.85348	10.00324	6.17338	19.85348	10	10.00647	99.93
19.64	783.532	19.89744	10.00324	6.15385	19.89744	10	10.00647	99.05
19.68	782.288	19.97802	10.00324	6.14408	19.97802	10	10.00647	99.93
19.72	778.557	20.02198	10.00324	6.11477	20.02198	10	10.00647	99.93
19.76	778.557	20.08059	10.00324	6.11477	20.08059	10	10.00647	100.81
19.8	771.095	20.09524	10.00324	6.05617	20.09524	10	10.00647	99.63
19.84	768.608	20.12454	10.00324	6.03663	20.12454	10	10.00647	99.93
19.88	767.364	20.14652	10.00324	6.02686	20.14652	10	10.00647	99.63
19.92	767.364	20.1685	10.00324	6.02686	20.1685	10	10.00647	99.93
19.96	769.851	20.1978	10.00324	6.0464	20.1978	10	10.00647	99.63
20	774.826	20.22711	10.00324	6.08547	20.22711	10	10.00647	99.93
20.04	778.557	20.26374	10.00324	6.11477	20.26374	10	10.00647	99.93
20.08	782.288	20.32234	10.00324	6.14408	20.32234	10	10.00647	99.93
20.12	782.288	20.38095	10.00324	6.14408	20.38095	10	10.00647	99.93
20.16	779.801	20.45421	10.00324	6.12454	20.45421	10	10.00647	99.93
20.2	774.826	20.51282	10.00324	6.08547	20.51282	10	10.00647	99.93
20.24	768.608	20.5641	10.00324	6.03663	20.5641	10	10.00647	99.93
20.28	759.902	20.58608	10.00324	5.96825	20.58608	10	10.00647	99.05
20.32	758.658	20.63004	10.00324	5.95849	20.63004	10	10.00647	99.93
20.36	753.683	20.63736	10.00324	5.91941	20.63736	10	10.00647	98.46
20.4	753.683	20.65934	10.00324	5.91941	20.65934	10	10.00647	99.34
20.44	756.171	20.68132	10.00324	5.93895	20.68132	10	10.00647	99.34
20.48	759.902	20.69597	10.00324	5.96825	20.69597	10	10.00647	99.93
20.52	766.12	20.7326	10.00324	6.01709	20.7326	10	10.00647	99.93
20.56	772.339	20.77656	10.00324	6.06593	20.77656	10	10.00647	99.93
20.6	776.07	20.83516	10.00324	6.09524	20.83517	10	10.00647	99.93
20.64	773.582	20.90842	10.00324	6.0757	20.90843	10	10.00647	99.63
20.68	768.608	20.98168	10.00324	6.03663	20.98169	10	10.00647	99.93
20.72	763.633	21.04029	10.00324	5.99756	21.04029	10	10.00647	99.93
20.76	756.171	21.06227	10.00324	5.93895	21.06227	10	10.00647	99.34
20.8	752.439	21.0989	10.00324	5.90965	21.0989	10	10.00647	99.34
20.84	748.708	21.11355	10.00324	5.88034	21.11355	10	10.00647	99.63
20.88	748.708	21.15018	10.00324	5.88034	21.15018	10	10.00647	99.93
20.92	748.708	21.17216	10.00324	5.88034	21.17216	10	10.00647	99.93
20.96	749.952	21.19414	10.00324	5.89011	21.19414	10	10.00647	99.63
21	754.927	21.22344	10.00324	5.92918	21.22344	10	10.00647	99.93
21.04	759.902	21.25275	10.00324	5.96825	21.25275	10	10.00647	99.93
21.08	763.633	21.30403	10.00324	5.99756	21.30403	10	10.00647	99.93
21.12	764.877	21.36996	10.00324	6.00733	21.36996	10	10.00647	99.93
21.16	761.145	21.4652	10.00324	5.97802	21.4652	10	10.00647	100.22
21.2	749.952	21.50183	10.00324	5.89011	21.50183	10	10.00647	98.75
21.24	747.465	21.56777	10.00324	5.87057	21.56777	10	10.00647	99.93
21.28	742.49	21.59707	10.00324	5.8315	21.59707	10	10.00647	99.93
21.32	738.759	21.61172	10.00324	5.8022	21.61172	10	10.00647	99.63

21.36	737.515	21.62637	10.00324	5.79243	21.62637	10	10.00647	99.63
21.4	735.028	21.62637	10.00324	5.77289	21.62637	10	10.00647	99.05
21.44	743.734	21.68498	10.00324	5.84127	21.68498	10	10.00647	100.51
21.48	747.465	21.68498	10.00324	5.87057	21.68498	10	10.00647	99.63
21.52	753.683	21.72161	10.00324	5.91941	21.72161	10	10.00647	99.63
21.56	759.902	21.77289	10.00324	5.96825	21.77289	10	10.00647	99.93
21.6	759.902	21.84615	10.00324	5.96825	21.84615	10	10.00647	99.63
21.64	754.927	21.92674	10.00324	5.92918	21.92674	10	10.00647	99.93
21.68	748.708	21.99267	10.00324	5.88034	21.99267	10	10.00647	99.93
21.72	743.734	22.03663	10.00324	5.84127	22.03663	10	10.00647	99.93
21.76	738.759	22.06593	10.00324	5.8022	22.06593	10	10.00647	99.93
21.8	735.028	22.08791	10.00324	5.77289	22.08791	10	10.00647	99.93
21.84	731.297	22.10989	10.00324	5.74359	22.10989	10	10.00647	99.63
21.88	731.297	22.13919	10.00324	5.74359	22.13919	10	10.00647	99.93
21.92	731.297	22.15385	10.00324	5.74359	22.15385	10	10.00647	99.93
21.96	736.271	22.18315	10.00324	5.78266	22.18315	10	10.00647	99.93
22	741.246	22.22711	10.00324	5.82173	22.22711	10	10.00647	100.51
22.04	743.734	22.27106	10.00324	5.84127	22.27106	10	10.00647	99.93
22.08	747.465	22.337	10.00324	5.87057	22.337	10	10.00647	100.51
22.12	744.977	22.38828	10.00324	5.85104	22.38828	10	10.00647	99.93
22.16	740.002	22.44689	10.00324	5.81197	22.44689	10	10.00647	100.22
22.2	735.028	22.50549	10.00324	5.77289	22.5055	10	10.00647	99.93
22.24	728.809	22.54212	10.00324	5.72405	22.54213	10	10.00647	99.93
22.28	727.565	22.57875	10.00324	5.71429	22.57876	10	10.00647	99.93
22.32	722.591	22.59341	10.00324	5.67521	22.59341	10	10.00647	99.93
22.36	721.347	22.60806	10.00324	5.66545	22.60806	10	10.00647	99.34
22.4	723.834	22.63004	10.00324	5.68498	22.63004	10	10.00647	99.93
22.44	728.809	22.65201	10.00324	5.72405	22.65202	10	10.00647	99.63
22.48	733.784	22.68132	10.00324	5.76313	22.68132	10	10.00647	99.93
22.52	741.246	22.73993	10.00324	5.82173	22.73993	10	10.00647	99.93
22.56	741.246	22.80586	10.00324	5.82173	22.80586	10	10.00647	99.93
22.6	737.515	22.88645	10.00324	5.79243	22.88645	10	10.00647	100.51
22.64	732.54	22.94505	10.00324	5.75336	22.94506	10	10.00647	100.22
22.68	727.565	22.98901	10.00324	5.71429	22.98901	10	10.00647	100.51
22.72	720.103	23.00366	10.00324	5.65568	23.00366	10	10.00647	99.34
22.76	718.86	23.03297	10.00324	5.64591	23.03297	10	10.00647	99.93
22.8	717.616	23.04762	10.00324	5.63614	23.04762	10	10.00647	99.93
22.84	718.86	23.0696	10.00324	5.64591	23.0696	10	10.00647	99.63
22.88	722.591	23.0989	10.00324	5.67521	23.0989	10	10.00647	99.34
22.92	727.565	23.12821	10.00324	5.71429	23.12821	10	10.00647	99.93
22.96	730.053	23.17949	10.00324	5.73382	23.17949	10	10.00647	99.93
23	731.297	23.24542	10.00324	5.74359	23.24542	10	10.00647	99.93
23.04	728.809	23.30403	10.00324	5.72405	23.30403	10	10.00647	99.34
23.08	726.322	23.36264	10.00324	5.70452	23.36264	10	10.00647	99.93
23.12	721.347	23.40659	10.00324	5.66545	23.40659	10	10.00647	99.93
23.16	717.616	23.4359	10.00324	5.63614	23.4359	10	10.00647	99.63
23.2	716.372	23.4652	10.00324	5.62637	23.4652	10	10.00647	99.93
23.24	716.372	23.49451	10.00324	5.62637	23.49451	10	10.00647	100.22
23.28	717.616	23.50916	10.00324	5.63614	23.50916	10	10.00647	99.63
23.32	721.347	23.53846	10.00324	5.66545	23.53846	10	10.00647	99.63
23.36	726.322	23.57509	10.00324	5.70452	23.57509	10	10.00647	99.63
23.4	731.297	23.64103	10.00324	5.74359	23.64103	10	10.00647	100.51
23.44	730.053	23.69231	10.00324	5.73382	23.69231	10	10.00647	99.93
23.48	727.565	23.75092	10.00324	5.71429	23.75092	10	10.00647	99.93
23.52	722.591	23.80952	10.00324	5.67521	23.80952	10	10.00647	99.63

23.56	720.103	23.83883	10.00324	5.65568	23.83883	10	10.00647	99.93
23.6	718.86	23.86813	10.00324	5.64591	23.86813	10	10.00647	99.93
23.64	717.616	23.90476	10.00324	5.63614	23.90476	10	10.00647	100.51
23.68	717.616	23.91209	10.00324	5.63614	23.91209	10	10.00647	99.93
23.72	720.103	23.93407	10.00324	5.65568	23.93407	10	10.00647	99.34
23.76	725.078	23.97802	10.00324	5.69475	23.97802	10	10.00647	99.93
23.8	728.809	24.0293	10.00324	5.72405	24.0293	10	10.00647	99.93
23.84	728.809	24.09524	10.00324	5.72405	24.09524	10	10.00647	99.93
23.88	725.078	24.1685	10.00324	5.69475	24.1685	10	10.00647	100.22
23.92	715.128	24.20513	10.00324	5.61661	24.20513	10	10.00647	99.34
23.96	713.885	24.24908	10.00324	5.60684	24.24908	10	10.00647	99.93
24	708.91	24.27839	10.00324	5.56777	24.27839	10	10.00647	99.93
24.04	707.666	24.30769	10.00324	5.558	24.30769	10	10.00647	99.93
24.08	706.423	24.32234	10.00324	5.54823	24.32234	10	10.00647	99.93
24.12	708.91	24.337	10.00324	5.56777	24.337	10	10.00647	99.93
24.16	712.641	24.3663	10.00324	5.59707	24.3663	10	10.00647	99.93
24.2	717.616	24.41026	10.00324	5.63614	24.41026	10	10.00647	99.93
24.24	720.103	24.46154	10.00324	5.65568	24.46154	10	10.00647	99.93
24.28	721.347	24.5348	10.00324	5.66545	24.5348	10	10.00647	99.93
24.32	716.372	24.58608	10.00324	5.62637	24.58608	10	10.00647	99.63
24.36	713.885	24.63736	10.00324	5.60684	24.63736	10	10.00647	99.93
24.4	710.154	24.67399	10.00324	5.57753	24.67399	10	10.00647	99.93
24.44	707.666	24.69597	10.00324	5.558	24.69597	10	10.00647	99.63
24.48	706.423	24.71795	10.00324	5.54823	24.71795	10	10.00647	99.93
24.52	707.666	24.73993	10.00324	5.558	24.73993	10	10.00647	99.34
24.56	712.641	24.77656	10.00324	5.59707	24.77656	10	10.00647	99.63
24.6	717.616	24.80586	10.00324	5.63614	24.80586	10	10.00647	99.93
24.64	718.86	24.86447	10.00324	5.64591	24.86447	10	10.00647	99.93
24.68	718.86	24.93773	10.00324	5.64591	24.93773	10	10.00647	99.93
24.72	716.372	24.98901	10.00324	5.62637	24.98901	10	10.00647	99.93
24.76	712.641	25.02564	10.00324	5.59707	25.02564	10	10.00647	100.22
24.8	711.397	25.06227	10.00324	5.5873	25.06227	10	10.00647	99.63
24.84	708.91	25.09158	10.00324	5.56777	25.09158	10	10.00647	99.93
24.88	710.154	25.11355	10.00324	5.57753	25.11355	10	10.00647	99.93
24.92	712.641	25.14286	10.00324	5.59707	25.14286	10	10.00647	99.93
24.96	716.372	25.17216	10.00324	5.62637	25.17216	10	10.00647	99.34
25	721.347	25.22344	10.00324	5.66545	25.22344	10	10.00647	99.93
25.04	723.834	25.27473	10.00324	5.68498	25.27473	10	10.00647	99.63
25.08	721.347	25.34799	10.00324	5.66545	25.34799	10	10.00647	99.93
25.12	716.372	25.40659	10.00324	5.62637	25.40659	10	10.00647	99.93
25.16	711.397	25.44322	10.00324	5.5873	25.44322	10	10.00647	99.93
25.2	707.666	25.47253	10.00324	5.558	25.47253	10	10.00647	99.93
25.24	706.423	25.48718	10.00324	5.54823	25.48718	10	10.00647	99.93
25.28	706.423	25.51648	10.00324	5.54823	25.51648	10	10.00647	99.63
25.32	708.91	25.53846	10.00324	5.56777	25.53846	10	10.00647	99.93
25.36	712.641	25.56777	10.00324	5.59707	25.56777	10	10.00647	99.93
25.4	722.591	25.61172	10.00324	5.67521	25.61172	10	10.00647	100.51
25.44	723.834	25.663	10.00324	5.68498	25.663	10	10.00647	99.63
25.48	723.834	25.71429	10.00324	5.68498	25.71429	10	10.00647	99.93
25.52	721.347	25.78022	10.00324	5.66545	25.78022	10	10.00647	99.93
25.56	716.372	25.8315	10.00324	5.62637	25.8315	10	10.00647	99.63
25.6	713.885	25.86813	10.00324	5.60684	25.86813	10	10.00647	99.93
25.64	710.154	25.90476	10.00324	5.57753	25.90476	10	10.00647	99.93
25.68	707.666	25.92674	10.00324	5.558	25.92674	10	10.00647	99.63
25.72	707.666	25.95604	10.00324	5.558	25.95604	10	10.00647	99.93

25.76	708.91	25.97802	10.00324	5.56777	25.97802	10	10.00647	99.93
25.8	713.885	26.00733	10.00324	5.60684	26.00733	10	10.00647	99.93
25.84	721.347	26.05861	10.00324	5.66545	26.05861	10	10.00647	100.51
25.88	723.834	26.09524	10.00324	5.68498	26.09524	10	10.00647	99.93
25.92	722.591	26.1685	10.00324	5.67521	26.1685	10	10.00647	99.93
25.96	716.372	26.23443	10.00324	5.62637	26.23443	10	10.00647	99.93
26	711.397	26.27839	10.00324	5.5873	26.27839	10	10.00647	99.63
26.04	706.423	26.29304	10.00324	5.54823	26.29304	10	10.00647	99.34
26.08	705.179	26.32967	10.00324	5.53846	26.32967	10	10.00647	99.93
26.12	705.179	26.35897	10.00324	5.53846	26.35897	10	10.00647	99.93
26.16	706.423	26.37363	10.00324	5.54823	26.37363	10	10.00647	99.34
26.2	711.397	26.40293	10.00324	5.5873	26.40293	10	10.00647	99.93
26.24	717.616	26.44689	10.00324	5.63614	26.44689	10	10.00647	99.63
26.28	722.591	26.49817	10.00324	5.67521	26.49817	10	10.00647	99.93
26.32	723.834	26.57143	10.00324	5.68498	26.57143	10	10.00647	100.51
26.36	717.616	26.63004	10.00324	5.63614	26.63004	10	10.00647	100.22
26.4	711.397	26.67399	10.00324	5.5873	26.67399	10	10.00647	99.93
26.44	706.423	26.71062	10.00324	5.54823	26.71062	10	10.00647	99.93
26.48	702.691	26.7326	10.00324	5.51893	26.7326	10	10.00647	99.63
26.52	702.691	26.75458	10.00324	5.51893	26.75458	10	10.00647	99.93
26.56	702.691	26.77656	10.00324	5.51893	26.77656	10	10.00647	99.34
26.6	708.91	26.80586	10.00324	5.56777	26.80586	10	10.00647	99.63
26.64	713.885	26.84249	10.00324	5.60684	26.84249	10	10.00647	99.63
26.68	717.616	26.89377	10.00324	5.63614	26.89377	10	10.00647	99.93
26.72	707.666	26.92308	10.00324	5.558	26.92308	10	10.00647	98.17
26.76	711.397	27.02564	10.00324	5.5873	27.02564	10	10.00647	99.93
26.8	706.423	27.06227	10.00324	5.54823	27.06227	10	10.00647	99.93
26.84	702.691	27.10623	10.00324	5.51893	27.10623	10	10.00647	99.93
26.88	700.204	27.12821	10.00324	5.49939	27.12821	10	10.00647	99.93
26.92	698.96	27.15018	10.00324	5.48962	27.15018	10	10.00647	99.93
26.96	701.448	27.17216	10.00324	5.50916	27.17216	10	10.00647	99.63
27	706.423	27.19414	10.00324	5.54823	27.19414	10	10.00647	99.93
27.04	711.397	27.2381	10.00324	5.5873	27.2381	10	10.00647	99.93
27.08	712.641	27.2967	10.00324	5.59707	27.2967	10	10.00647	99.34
27.12	716.372	27.39927	10.00324	5.62637	27.39927	10	10.00647	100.81
27.16	706.423	27.4359	10.00324	5.54823	27.4359	10	10.00647	100.22
27.2	698.96	27.47253	10.00324	5.48962	27.47253	10	10.00647	99.63
27.24	692.742	27.50183	10.00324	5.44078	27.50183	10	10.00647	99.93
27.28	689.011	27.51648	10.00324	5.41148	27.51648	10	10.00647	99.34
27.32	690.254	27.54579	10.00324	5.42125	27.54579	10	10.00647	99.63
27.36	693.986	27.56777	10.00324	5.45055	27.56777	10	10.00647	99.93
27.4	700.204	27.58974	10.00324	5.49939	27.58974	10	10.00647	99.63
27.44	706.423	27.6337	10.00324	5.54823	27.6337	10	10.00647	99.93
27.48	708.91	27.70696	10.00324	5.56777	27.70696	10	10.00647	99.93
27.52	703.935	27.78022	10.00324	5.52869	27.78022	10	10.00647	99.93
27.56	698.96	27.82418	10.00324	5.48962	27.82418	10	10.00647	99.93
27.6	693.986	27.86081	10.00324	5.45055	27.86081	10	10.00647	99.93
27.64	691.498	27.88278	10.00324	5.43101	27.88278	10	10.00647	99.93
27.68	687.767	27.89744	10.00324	5.40171	27.89744	10	10.00647	99.05
27.72	692.742	27.91941	10.00324	5.44078	27.91941	10	10.00647	99.34
27.76	700.204	27.95604	10.00324	5.49939	27.95604	10	10.00647	99.93
27.8	708.91	27.99267	10.00324	5.56777	27.99267	10	10.00647	99.63
27.84	710.154	28.05128	10.00324	5.57753	28.05128	10	10.00647	99.63
27.88	710.154	28.10989	10.00324	5.57753	28.10989	10	10.00647	99.63
27.92	706.423	28.1685	10.00324	5.54823	28.1685	10	10.00647	99.63

27.96	702.691	28.21245	10.00324	5.51893	28.21245	10	10.00647	99.93
28	697.717	28.25641	10.00324	5.47985	28.25641	10	10.00647	99.93
28.04	695.229	28.27839	10.00324	5.46032	28.27839	10	10.00647	99.63
28.08	693.986	28.30769	10.00324	5.45055	28.30769	10	10.00647	99.93
28.12	695.229	28.337	10.00324	5.46032	28.337	10	10.00647	99.93
28.16	698.96	28.3663	10.00324	5.48962	28.3663	10	10.00647	99.63
28.2	703.935	28.40293	10.00324	5.52869	28.40293	10	10.00647	99.93
28.24	706.423	28.45421	10.00324	5.54823	28.45421	10	10.00647	99.93
28.28	705.179	28.52015	10.00324	5.53846	28.52015	10	10.00647	99.93
28.32	691.498	28.5348	10.00324	5.43101	28.5348	10	10.00647	98.17
28.36	692.742	28.60073	10.00324	5.44078	28.60073	10	10.00647	99.34
28.4	690.254	28.63736	10.00324	5.42125	28.63736	10	10.00647	99.63
28.44	691.498	28.65934	10.00324	5.43101	28.65934	10	10.00647	99.34
28.48	695.229	28.68864	10.00324	5.46032	28.68865	10	10.00647	99.93
28.52	703.935	28.72527	10.00324	5.52869	28.72528	10	10.00647	100.51
28.56	708.91	28.76923	10.00324	5.56777	28.76923	10	10.00647	99.93
28.6	707.666	28.82784	10.00324	5.558	28.82784	10	10.00647	100.22
28.64	687.767	28.83516	10.00324	5.40171	28.83517	10	10.00647	99.93
28.68	680.305	28.84982	10.00324	5.3431	28.84982	10	10.00647	99.93
28.72	677.817	28.87179	10.00324	5.32357	28.8718	10	10.00647	100.51
28.76	671.599	28.85714	10.00324	5.27473	28.85714	10	10.00647	99.63
28.8	666.624	28.86447	10.00324	5.23565	28.86447	10	10.00647	99.93
28.84	662.893	28.86447	10.00324	5.20635	28.86447	10	10.00647	99.93
28.88	660.406	28.87179	10.00324	5.18681	28.8718	10	10.00647	99.63
28.92	660.406	28.89377	10.00324	5.18681	28.89377	10	10.00647	100.51
28.96	659.162	28.88645	10.00324	5.17705	28.88645	10	10.00647	100.51
29	654.187	28.87179	10.00324	5.13797	28.8718	10	10.00647	99.63

Appendix D: Triaxial test

HCTCRB: confining pressure 150 kPa

IPC Global Universal Testing Machine
UTM_12 V2.00 Stress - Strain Test

Filename	D:\my research\Lab test Data\Triaxial\CR2GPC\UU-test no1\CR2GPC-triaxial-150kPa.B12								
Operator	Mr.Peerapong Jitsangiam								
Test type	Compression test								
Notes/Comments		CR2GPC							
Specimen shape	Cylindrical								
Specimen Information									
********************									
Identification	CR2GPC								
Core/Sample Number									
Dimensions	Point 1	Point 2	Point 3	Point 4	Point 5	Point 6	Average	Std Dev.	
Diameter (mm)	100						100		
Height (mm)	100						100		
Cross-Sectional area	7853.982								
Volume	785398.2								
Comments/Properties									
Setup Parameters									
****************									
Pre-load stress (kPa)									
Pre-load load (kN)									
Pre-load hold time (s)									
Confining pressure (kPa)	150								
Confining hold time (s)	10								
Dump pressure at end of test	Yes								
Axial gauge length (mm)	100								
Radial gauge length (mm)									
Advanced loading control	Disabled								
Control Mode	Displacement (actuator)								
Loading Rate (mm/s)	1								
Termination Timer (sec)	0								
% Unload	0								
Minimum stress (kPa)	0								
Minimum load (kN)	0								
Termination Actuator (mm)	0								
Termination Axial (mm)	250								
Termination Radial (mm)	0								
Calibration Information									
***********************									
Channel description	Filename	Transducer description	Span	Units	Date	Linearised			
A: Axial Force	Y12346.CAR	STC5000 S/N: Y12346 +/- 20kN	40	kN	7/12/2005	No			
B: Actuator LVDT	941C-340.CAR	AC-15 S/N: M992941C-340 +/-15mm	30	mm	7/12/2005	No			
C: Axial LVDT #1	83047.car	D6-05000A S/N: 83047 +/- 5mm	10	mm	20/12/2005	Yes			
D: Axial LVDT #2	83048.car	D6-05000A S/N: 83048 +/- 5mm	10	mm	20/12/2005	Yes			
E: Radial LVDT #1	S054041.CAR	IT2000AG S/N: S054041 +/-600kPa	1200	kPa	22/01/2004	No			
F: Radial LVDT #2		Undefined/Not Used	1	?		No			
G: Temperature Probe		Undefined/Not Used	1	?		No			
H: Confining Pressure	S054041.CAR	IT2000AG S/N: S054041 +/-600kPa	1200	kPa	22/01/2004	No			
Test Results									
************									
Start date and time	Monday	December 11	2006	at 11:58 AM					
Timer (sec)	30								
Peak compressive stress (kPa)	1608.1								
Peak load (kN)	12.63								
Actuator strain at peak load (%)	5.429								
Actuator deformation at peak load (mm)	5.429								
Axial av. strain at peak load (%)	4.473								
Axial av. deform. at peak load (mm)	4.473								
Time	Stress	Actuator Strain	Axial average strain	Load	Actuator	Axial LVDT #1	Axial LVDT #2	Confining Pressure	
(sec)	(kPa)	(%)	(%)	(kN)	(mm)	(mm)	(mm)	(kPa)	
0	2.487	0	0	0.01954	0	0	0	149.74	
0.04	11.193	0.41758	0	0.08791	0.417582	0	0	150.33	
0.08	9.95	0.44689	0.02101	0.07814	0.446886	0.027497	0.01453	150.04	
0.12	9.95	0.49084	0.05825	0.07814	0.490842	0.06486	0.051648	150.04	
0.16	8.706	0.52015	0.09317	0.06838	0.520147	0.102222	0.084127	149.74	

Appendix D: Triaxial test

0.2	8.706	0.55678	0.13138	0.06838	0.556777	0.141856	0.120904	149.74
0.24	8.706	0.59341	0.17051	0.06838	0.593407	0.183785	0.157241	149.74
0.28	9.95	0.64469	0.21192	0.07814	0.644689	0.225714	0.19812	149.74
0.32	11.193	0.68132	0.24755	0.08791	0.681319	0.265177	0.229915	149.74
0.36	19.899	0.7033	0.26896	0.15629	0.703297	0.289841	0.248083	149.74
0.4	32.336	0.74725	0.29739	0.25397	0.747253	0.319438	0.275336	150.33
0.44	42.286	0.77656	0.32932	0.33211	0.776557	0.351502	0.307131	149.74
0.48	54.723	0.82051	0.36524	0.42979	0.820513	0.388498	0.341978	149.74
0.52	67.16	0.85714	0.40223	0.52747	0.857143	0.420562	0.383907	149.45
0.56	79.597	0.90842	0.4417	0.62515	0.908425	0.450159	0.433236	149.74
0.6	90.79	0.95238	0.48239	0.71306	0.952381	0.482222	0.482564	149.74
0.64	103.227	0.99634	0.52186	0.81074	0.996337	0.521685	0.522027	149.74
0.68	115.664	1.05495	0.56502	0.90842	1.054945	0.563614	0.566422	150.33
0.72	121.883	1.07692	0.58717	0.95726	1.076923	0.585812	0.588523	149.74
0.76	133.076	1.11355	0.61905	1.04518	1.113553	0.617827	0.620269	149.74
0.8	144.269	1.16484	0.65568	1.13309	1.164835	0.654457	0.656899	150.33
0.84	154.219	1.19414	0.68987	1.21123	1.194139	0.688645	0.691087	149.74
0.88	166.656	1.23077	0.72039	1.30891	1.230769	0.720391	0.720391	149.45
0.92	179.093	1.27473	0.75946	1.40659	1.274725	0.757021	0.761905	149.74
0.96	194.017	1.31868	0.79243	1.52381	1.318681	0.791209	0.793651	149.74
1	210.186	1.36996	0.83394	1.65079	1.369963	0.832723	0.835165	150.92
1.04	222.623	1.39927	0.86325	1.74847	1.399267	0.862027	0.864469	150.33
1.08	237.547	1.4359	0.89744	1.86569	1.435897	0.896215	0.898657	149.74
1.12	248.74	1.47985	0.93407	1.9536	1.479853	0.932845	0.935287	149.45
1.16	264.908	1.51648	0.96581	2.08059	1.516484	0.964591	0.967033	149.74
1.2	281.077	1.55311	1	2.20757	1.553114	0.998779	1.001221	149.74
1.24	294.757	1.59707	1.03663	2.31502	1.59707	1.035409	1.037851	149.74
1.28	308.438	1.64103	1.07698	2.42247	1.641026	1.074481	1.079487	149.74
1.32	323.362	1.67766	1.10519	2.53968	1.677656	1.103761	1.106618	149.74
1.36	338.287	1.71429	1.13938	2.6569	1.714286	1.137607	1.141148	149.74
1.4	354.455	1.75092	1.16868	2.78388	1.750916	1.166618	1.170745	149.45
1.44	373.11	1.78022	1.20043	2.9304	1.78022	1.198046	1.202808	149.74
1.48	393.01	1.8315	1.2395	3.08669	1.831502	1.236728	1.242271	149.74
1.52	412.909	1.86813	1.27127	3.24298	1.868132	1.265739	1.276801	149.74
1.56	434.052	1.91209	1.30788	3.40904	1.912088	1.30442	1.311331	149.74
1.6	452.707	1.94872	1.3407	3.55556	1.948718	1.335849	1.345543	149.74
1.64	477.581	2.00733	1.382	3.75092	2.007326	1.376947	1.387057	150.62
1.68	492.506	2.0293	1.40873	3.86813	2.029304	1.403541	1.413919	149.74
1.72	512.405	2.07326	1.44275	4.02442	2.07326	1.437387	1.448107	149.74
1.76	534.792	2.10989	1.47313	4.20024	2.10989	1.466398	1.479853	149.74
1.8	555.935	2.14652	1.50592	4.3663	2.14652	1.500244	1.5116	149.74
1.84	578.321	2.19048	1.53994	4.54212	2.190476	1.53409	1.545788	149.74
1.88	600.708	2.23443	1.57275	4.71795	2.234432	1.565519	1.579976	149.74
1.92	606.926	2.28571	1.63126	4.76679	2.285714	1.623932	1.638584	149.74
1.96	623.095	2.31502	1.65201	4.89377	2.315018	1.64591	1.65812	149.74
2	640.506	2.34432	1.67277	5.03053	2.344322	1.667888	1.677656	149.16
2.04	666.624	2.38828	1.7033	5.23565	2.388278	1.697192	1.709402	150.33
2.08	687.767	2.41758	1.73016	5.40171	2.417582	1.724054	1.736264	149.74
2.12	711.397	2.45421	1.76435	5.5873	2.454212	1.758242	1.770452	149.74
2.16	735.028	2.49084	1.79609	5.77289	2.490842	1.789988	1.802198	149.74
2.2	757.414	2.5348	1.83045	5.94872	2.534799	1.824176	1.836728	149.74
2.24	779.801	2.5641	1.85857	6.12454	2.564103	1.850818	1.866325	149.45
2.28	804.675	2.60806	1.89153	6.3199	2.608059	1.884664	1.898388	149.74
2.32	827.062	2.65201	1.92695	6.49573	2.652015	1.91851	1.935385	149.74
2.36	846.961	2.67399	1.95625	6.65201	2.673993	1.947521	1.964982	149.16
2.4	869.347	2.7326	1.99777	6.82784	2.732601	1.98862	2.006911	149.74
2.44	889.247	2.76923	2.03316	6.98413	2.769231	2.024884	2.041441	150.04
2.48	910.39	2.80586	2.06236	7.15018	2.805861	2.053895	2.070818	149.74
2.52	931.533	2.84249	2.0928	7.31624	2.842491	2.08547	2.100122	149.74
2.56	951.432	2.87179	2.11966	7.47253	2.871795	2.10989	2.129426	149.16
2.6	973.818	2.91575	2.15385	7.64835	2.915751	2.144078	2.163614	149.74
2.64	992.474	2.95971	2.18803	7.79487	2.959707	2.178266	2.197802	149.74
2.68	1011.129	2.98901	2.21612	7.94139	2.989011	2.20757	2.224664	149.45
2.72	1029.785	3.02564	2.24298	8.08791	3.025641	2.234432	2.251526	149.74
2.76	1047.197	3.05495	2.27473	8.22466	3.054945	2.263736	2.285714	149.74
2.8	1065.852	3.09158	2.30547	8.37118	3.091575	2.295482	2.315458	149.74
2.84	1083.264	3.12821	2.33753	8.50794	3.128205	2.327228	2.347839	149.74
2.88	1100.676	3.16484	2.36713	8.64469	3.164835	2.356532	2.377729	149.74
2.92	1118.088	3.20147	2.39797	8.78144	3.201465	2.385836	2.41011	149.74
2.96	1137.987	3.25275	2.4325	8.93773	3.252747	2.420024	2.444982	150.92
3	1151.668	3.2674	2.45839	9.04518	3.267399	2.446886	2.46989	149.74
3.04	1166.592	3.31136	2.49661	9.16239	3.311355	2.485958	2.507253	149.74
3.08	1181.517	3.34066	2.52867	9.27961	3.340659	2.517705	2.539634	149.74
3.12	1198.928	3.38462	2.55937	9.41636	3.384615	2.547009	2.571722	149.74
3.16	1213.853	3.42125	2.59005	9.53358	3.421245	2.576313	2.603785	149.74
3.2	1228.777	3.45055	2.62317	9.65079	3.450549	2.610501	2.635849	149.45
3.24	1244.945	3.49451	2.65386	9.77778	3.494505	2.639805	2.667912	149.74
3.28	1259.87	3.53114	2.68698	9.89499	3.531136	2.673993	2.699976	149.74
3.32	1277.282	3.57509	2.72625	10.03175	3.575092	2.713065	2.739438	150.33
3.36	1289.719	3.6044	2.7557	10.12943	3.604396	2.742369	2.769035	149.74
3.4	1304.643	3.64103	2.78884	10.24664	3.641026	2.774115	2.803565	149.74
3.44	1315.836	3.67033	2.81829	10.33455	3.67033	2.803419	2.833162	149.16
3.48	1330.761	3.71429	2.8551	10.45177	3.714286	2.840049	2.870159	149.74
3.52	1344.441	3.75092	2.88455	10.55922	3.750916	2.869353	2.899756	149.74
3.56	1358.122	3.78755	2.92137	10.66667	3.787546	2.905983	2.936752	149.74
3.6	1370.559	3.82418	2.95573	10.76435	3.824176	2.940171	2.971282	149.74
3.64	1382.996	3.86813	2.99254	10.86203	3.868132	2.976801	3.008278	149.45
3.68	1395.433	3.90476	3.0269	10.95971	3.904762	3.010989	3.042808	150.04

3.72	1407.87	3.94872	3.06741	11.05739	3.948718	3.052552	3.082271	150.04
3.76	1417.82	3.97802	3.10071	11.13553	3.978022	3.084615	3.116801	149.74
3.8	1425.282	3.99267	3.12661	11.19414	3.992674	3.111746	3.141465	148.57
3.84	1438.963	4.04396	3.16853	11.30159	4.043956	3.153675	3.183394	148.86
3.88	1452.644	4.10256	3.2117	11.40904	4.102564	3.195604	3.22779	149.74
3.92	1460.106	4.14652	3.24993	11.46764	4.14652	3.235067	3.264786	149.74
3.96	1473.786	4.21245	3.30295	11.57509	4.212454	3.286862	3.319048	150.92
4	1478.761	4.23443	3.33366	11.61416	4.234432	3.318681	3.348645	149.74
4.04	1487.467	4.27106	3.37049	11.68254	4.271062	3.352869	3.388107	149.74
4.08	1497.417	4.31502	3.40852	11.76068	4.315018	3.391941	3.425104	149.74
4.12	1504.879	4.35897	3.44779	11.81929	4.358974	3.431013	3.464567	149.74
4.16	1512.341	4.3956	3.48706	11.8779	4.395604	3.470085	3.504029	149.74
4.2	1521.047	4.43956	3.52878	11.94628	4.43956	3.5116	3.545958	149.74
4.24	1527.266	4.47619	3.56441	11.99512	4.47619	3.548327	3.580488	149.74
4.28	1534.728	4.52747	3.61004	12.05372	4.527473	3.595189	3.624884	150.33
4.32	1540.946	4.5641	3.6495	12.10256	4.564103	3.632186	3.666813	149.74
4.36	1545.921	4.60806	3.69389	12.14164	4.608059	3.679048	3.708742	149.74
4.4	1553.383	4.66667	3.74199	12.20024	4.666667	3.72591	3.758071	150.33
4.44	1555.871	4.69597	3.77775	12.21978	4.695971	3.762906	3.792601	149.74
4.48	1560.846	4.73993	3.82204	12.25885	4.739927	3.807082	3.836996	149.74
4.52	1564.577	4.78388	3.86499	12.28816	4.783883	3.848596	3.881392	149.74
4.56	1568.308	4.82051	3.90672	12.31746	4.820513	3.89011	3.923321	149.74
4.6	1574.526	4.87179	3.94966	12.3663	4.871795	3.934066	3.96525	149.74
4.64	1577.014	4.90842	3.98893	12.38584	4.908425	3.973138	4.004713	149.74
4.68	1581.988	4.95238	4.0331	12.42491	4.952381	4.017094	4.049109	149.74
4.72	1585.72	5.01099	4.07973	12.45421	5.010989	4.063492	4.095971	150.33
4.76	1586.963	5.04029	4.11777	12.46398	5.040293	4.102564	4.132967	149.74
4.8	1589.451	5.08425	4.15949	12.48352	5.084249	4.144078	4.174896	149.74
4.84	1591.938	5.12821	4.20488	12.50305	5.128205	4.190476	4.219292	149.74
4.88	1594.425	5.17216	4.24661	12.52259	5.172161	4.23199	4.261221	149.74
4.92	1595.669	5.21612	4.28938	12.53236	5.216117	4.273504	4.30525	149.45
4.96	1599.4	5.26007	4.33311	12.56166	5.260073	4.317021	4.349206	150.33
5	1601.888	5.30403	4.37564	12.5812	5.304029	4.35812	4.393162	149.74
5.04	1601.888	5.34799	4.41814	12.5812	5.347985	4.404054	4.432234	149.74
5.08	1608.106	5.42857	4.47282	12.63004	5.428571	4.457241	4.4884	150.92
5.12	1601.888	5.4359	4.50812	12.5812	5.435897	4.491087	4.525153	149.74
5.16	1601.888	5.47985	4.5498	12.5812	5.479853	4.534994	4.564615	149.74
5.2	1601.888	5.53114	4.6016	12.5812	5.531136	4.586789	4.61641	150.04
5.24	1596.913	5.58242	4.65216	12.54212	5.582418	4.638584	4.665739	149.74
5.28	1594.425	5.61905	4.69902	12.52259	5.619048	4.685446	4.712601	149.74
5.32	1591.938	5.67033	4.74342	12.50305	5.67033	4.729841	4.756996	149.74
5.36	1590.694	5.70696	4.78241	12.49328	5.70696	4.769084	4.795726	149.74
5.4	1589.451	5.74359	4.81849	12.48352	5.74359	4.804982	4.83199	149.74
5.44	1588.207	5.77289	4.85457	12.47375	5.772894	4.840879	4.868254	149.74
5.48	1588.207	5.81685	4.89065	12.47375	5.81685	4.876777	4.904518	149.74
5.52	1590.694	5.84615	4.92913	12.49328	5.846154	4.915067	4.943199	150.33
5.56	1593.182	5.89011	4.964	12.51282	5.89011	4.950965	4.977045	150.04
5.6	1593.182	5.93407	5.01123	12.51282	5.934066	4.998828	5.023639	149.74
5.64	1590.694	5.97802	5.05602	12.49328	5.978022	5.043565	5.068474	149.16
5.68	1588.207	6.02198	5.10833	12.47375	6.021978	5.095873	5.120781	149.45
5.72	1584.476	6.07326	5.15565	12.44444	6.07326	5.143199	5.168107	149.74
5.76	1579.501	6.11722	5.20049	12.40537	6.117216	5.188034	5.212943	149.74
5.8	1575.77	6.1685	5.244	12.37607	6.168498	5.232869	5.25514	150.04
5.84	1569.551	6.18315	5.27576	12.32723	6.18315	5.264957	5.286569	149.16
5.88	1568.308	6.22711	5.31221	12.31746	6.227106	5.301587	5.322833	149.45
5.92	1565.82	6.26374	5.34867	12.29792	6.263736	5.340659	5.356679	149.74
5.96	1562.089	6.28571	5.38267	12.26862	6.285714	5.372405	5.392943	149.16
6	1562.089	6.32234	5.41669	12.26862	6.322344	5.406593	5.426789	149.45
6.04	1563.333	6.3663	5.45315	12.27839	6.3663	5.445665	5.460635	149.74
6.08	1563.333	6.41026	5.5007	12.27839	6.410256	5.492063	5.509328	150.04
6.12	1563.333	6.45421	5.54611	12.27839	6.454212	5.53602	5.55619	149.74
6.16	1562.089	6.50549	5.59027	12.26862	6.505495	5.582418	5.59812	149.74
6.2	1555.871	6.54945	5.64304	12.21978	6.549451	5.6337	5.652381	149.74
6.24	1550.896	6.59341	5.68844	12.18071	6.593407	5.680098	5.696777	149.74
6.28	1548.409	6.65201	5.73745	12.16117	6.652015	5.728938	5.745958	150.92
6.32	1540.946	6.66667	5.76054	12.10256	6.666667	5.753358	5.767717	149.74
6.36	1538.459	6.7033	5.79698	12.08303	6.703297	5.789988	5.80398	149.74
6.4	1535.972	6.72527	5.82614	12.06349	6.725275	5.819292	5.832991	149.74
6.44	1535.972	6.7619	5.85895	12.06349	6.761905	5.85348	5.86442	149.45
6.48	1539.703	6.79853	5.89781	12.0928	6.798535	5.89011	5.905519	149.74
6.52	1540.946	6.84249	5.9367	12.10256	6.842491	5.931624	5.941783	149.74
6.56	1540.946	6.89377	5.98662	12.10256	6.893773	5.982906	5.99033	149.74
6.6	1538.459	6.94505	6.04211	12.08303	6.945055	6.037167	6.047057	149.74
6.64	1530.997	6.99634	6.09391	12.02442	6.996337	6.088962	6.098852	149.45
6.68	1523.534	7.05495	6.15433	11.96581	7.054945	6.150623	6.158046	150.33
6.72	1506.123	7.10623	6.216	11.82906	7.106227	6.212283	6.219707	150.04
6.76	1494.929	7.15018	6.25989	11.74115	7.150183	6.25641	6.26337	149.74
6.8	1487.467	7.19414	6.29513	11.68254	7.194139	6.29304	6.297216	150.33
6.84	1478.761	7.20147	6.31579	11.61416	7.201465	6.315018	6.316557	149.74
6.88	1476.274	7.22344	6.34009	11.59463	7.223443	6.339438	6.340733	149.45
6.92	1476.274	7.25275	6.36559	11.59463	7.252747	6.363858	6.367326	150.04
6.96	1478.761	7.27473	6.38989	11.61416	7.274725	6.388278	6.391502	149.74
7	1484.98	7.30403	6.41662	11.663	7.304029	6.41514	6.418095	149.74
7.04	1492.442	7.33333	6.447	11.72161	7.333333	6.446886	6.447106	149.74
7.08	1497.417	7.36996	6.48969	11.76068	7.369963	6.488547	6.490842	149.45
7.12	1499.904	7.4359	6.54614	11.78022	7.435897	6.545275	6.547009	149.45
7.16	1497.417	7.50183	6.61364	11.76068	7.501832	6.614335	6.612943	150.33
7.2	1487.467	7.56044	6.67745	11.68254	7.56044	6.678462	6.676435	149.74

7.24	1477.518	7.6044	6.73016	11.6044	7.604396	6.732601	6.727717	149.74
7.28	1467.568	7.64835	6.77411	11.52625	7.648352	6.776557	6.771673	149.74
7.32	1458.862	7.67766	6.8083	11.45788	7.677656	6.810745	6.805861	149.45
7.36	1453.887	7.71429	6.84005	11.4188	7.714286	6.842491	6.837607	149.74
7.4	1451.4	7.74359	6.86935	11.39927	7.74359	6.871795	6.866911	149.74
7.44	1451.4	7.77289	6.89621	11.39927	7.772894	6.898657	6.893773	150.04
7.48	1450.156	7.8022	6.92308	11.3895	7.802198	6.925519	6.920635	150.04
7.52	1452.644	7.82418	6.95604	11.40904	7.824176	6.957265	6.954823	149.74
7.56	1456.375	7.86813	6.99509	11.43834	7.868132	6.996654	6.993529	149.74
7.6	1462.593	7.92674	7.04516	11.48718	7.92674	7.048449	7.04188	150.92
7.64	1458.862	7.96337	7.08912	11.45788	7.96337	7.092845	7.085397	149.74
7.68	1457.618	8.01465	7.14408	11.44811	8.014652	7.149573	7.138584	149.74
7.72	1450.156	8.05861	7.19413	11.3895	8.058608	7.198901	7.189353	148.86
7.76	1446.425	8.10989	7.24018	11.3602	8.10989	7.245079	7.235287	149.74
7.8	1440.206	8.14652	7.2837	11.31136	8.14652	7.288596	7.278803	149.74
7.84	1433.988	8.18315	7.31875	11.26252	8.18315	7.32486	7.31265	149.74
7.88	1427.769	8.21978	7.35502	11.21368	8.21978	7.358706	7.351331	149.74
7.92	1422.795	8.25641	7.39007	11.1746	8.25641	7.394969	7.385177	149.74
7.96	1419.064	8.28571	7.42271	11.1453	8.285714	7.426398	7.419023	149.74
8	1417.82	8.32234	7.45786	11.13553	8.322344	7.462857	7.452869	149.74
8.04	1417.82	8.35165	7.48961	11.13553	8.351648	7.494921	7.484298	149.74
8.08	1419.064	8.3956	7.52745	11.1453	8.395604	7.531917	7.522979	150.04
8.12	1420.307	8.43223	7.5702	11.15507	8.432234	7.576313	7.564078	149.74
8.16	1420.307	8.46886	7.61292	11.15507	8.468864	7.618242	7.607595	149.74
8.2	1420.307	8.52747	7.66543	11.15507	8.527473	7.672503	7.658364	149.74
8.24	1416.576	8.57875	7.71874	11.12576	8.578755	7.726227	7.711258	149.74
8.28	1410.358	8.62271	7.76565	11.07692	8.622711	7.774579	7.756728	149.74
8.32	1404.139	8.66667	7.81255	11.02808	8.666667	7.820513	7.804591	149.74
8.36	1397.921	8.71795	7.85585	10.97924	8.717949	7.864029	7.847668	149.74
8.4	1390.458	8.75458	7.89794	10.92063	8.754579	7.905128	7.890745	149.74
8.44	1379.265	8.7619	7.92079	10.83272	8.761905	7.929304	7.912283	149.16
8.48	1379.265	8.81319	7.95849	10.83272	8.813187	7.968523	7.948449	149.74
8.52	1375.534	8.83516	7.98656	10.80342	8.835165	7.995653	7.97746	149.74
8.56	1378.021	8.86447	8.01586	10.82295	8.864469	8.02525	8.006471	149.74
8.6	1381.753	8.89377	8.04882	10.85226	8.893773	8.057314	8.040317	149.74
8.64	1384.24	8.93773	8.083	10.87179	8.937729	8.091844	8.074164	149.74
8.68	1387.971	8.97436	8.12696	10.9011	8.974359	8.136239	8.11768	149.74
8.72	1387.971	9.02564	8.18063	10.9011	9.025641	8.190476	8.170794	149.74
8.76	1386.727	9.09158	8.24349	10.89133	9.091575	8.253968	8.233016	149.74
8.8	1381.753	9.14286	8.29668	10.85226	9.142857	8.307692	8.285665	150.04
8.84	1373.047	9.18681	8.34503	10.78388	9.186813	8.356532	8.333529	149.74
8.88	1365.584	9.23077	8.38371	10.72527	9.230769	8.395604	8.371819	149.74
8.92	1361.853	9.26007	8.42121	10.69597	9.260073	8.432234	8.410183	149.74
8.96	1356.878	9.2967	8.4528	10.6569	9.296703	8.46398	8.441612	149.74
9	1353.147	9.31868	8.47952	10.62759	9.318681	8.490842	8.468205	149.45
9.04	1353.147	9.34066	8.50625	10.62759	9.340659	8.517705	8.494799	149.74
9.08	1356.878	9.37729	8.53662	10.6569	9.377289	8.547009	8.526227	149.74
9.12	1360.61	9.41392	8.57549	10.6862	9.413919	8.586081	8.564908	149.74
9.16	1361.853	9.45788	8.62166	10.69597	9.457875	8.632479	8.610842	149.45
9.2	1363.097	9.51648	8.67744	10.70574	9.516484	8.688645	8.666227	149.74
9.24	1359.366	9.56777	8.73062	10.67643	9.567766	8.742369	8.718877	149.45
9.28	1353.147	9.62637	8.78742	10.62759	9.626374	8.798535	8.776313	149.74
9.32	1345.685	9.67033	8.82974	10.56899	9.67033	8.842491	8.816996	149.45
9.36	1338.223	9.69231	8.86601	10.51038	9.692308	8.879121	8.852894	149.45
9.4	1335.736	9.72894	8.90228	10.49084	9.728938	8.913309	8.891258	149.74
9.44	1332.004	9.75824	8.93034	10.46154	9.758242	8.942833	8.917851	149.45
9.48	1330.761	9.79487	8.95841	10.45177	9.794872	8.969963	8.946862	149.74
9.52	1333.248	9.81685	8.98527	10.47131	9.81685	8.997094	8.973455	149.74
9.56	1334.492	9.84615	9.01335	10.48107	9.846154	9.024225	9.002466	149.16
9.6	1341.954	9.88278	9.05853	10.53968	9.882784	9.071087	9.045983	149.74
9.64	1344.441	9.93407	9.10493	10.55922	9.934066	9.117949	9.091917	149.74
9.68	1345.685	9.99267	9.15863	10.56899	9.992674	9.172161	9.145104	149.45
9.72	1341.954	10.03663	9.21208	10.53968	10.03663	9.223443	9.200708	149.16
9.76	1338.223	10.09524	9.26918	10.51038	10.095238	9.282051	9.256313	149.74
9.8	1333.248	10.14652	9.31413	10.47131	10.14652	9.326007	9.302247	149.74
9.84	1328.273	10.18315	9.353	10.43223	10.18315	9.365079	9.340928	150.33
9.88	1323.299	10.21245	9.38584	10.39316	10.212454	9.399267	9.372405	149.74
9.92	1315.836	10.22711	9.41111	10.33455	10.227106	9.422955	9.399267	148.86
9.96	1317.08	10.27106	9.44427	10.34432	10.271062	9.455092	9.433455	149.74
10	1318.324	10.30037	9.47033	10.35409	10.300366	9.480342	9.460317	149.74
10.04	1322.055	10.32967	9.49998	10.38339	10.32967	9.507888	9.492063	149.74
10.08	1330.761	10.38828	9.54261	10.45177	10.388278	9.549206	9.53602	150.92
10.12	1330.761	10.41026	9.57814	10.45177	10.410256	9.583639	9.57265	149.74
10.16	1330.761	10.47619	9.63665	10.45177	10.47619	9.63873	9.634579	149.74
10.2	1327.03	10.5348	9.69752	10.42247	10.534799	9.69475	9.700293	149.74
10.24	1323.299	10.58608	9.75602	10.39316	10.586081	9.746032	9.766007	150.04
10.28	1315.836	10.62271	9.80106	10.33455	10.622711	9.787546	9.814579	149.74
10.32	1310.862	10.65934	9.83816	10.29548	10.659341	9.821734	9.854579	149.74
10.36	1305.887	10.68132	9.86873	10.25641	10.681319	9.848596	9.888864	149.74
10.4	1304.643	10.71062	9.89933	10.24664	10.710623	9.880342	9.918315	149.74
10.44	1302.156	10.72527	9.9207	10.22711	10.725275	9.899878	9.941514	149.16
10.48	1309.618	10.76923	9.95287	10.28571	10.769231	9.934066	9.971673	149.74
10.52	1313.349	10.81319	9.98736	10.31502	10.813187	9.968254	10.006471	150.04
10.56	1315.836	10.85714	10.00324	10.33455	10.857143	10	10.006471	149.74
10.6	1314.593	10.91575	10.00324	10.32479	10.915751	10	10.006471	149.74
10.64	1310.862	10.97436	10.00324	10.29548	10.974359	10	10.006471	149.74
10.68	1303.399	11.01832	10.00324	10.23687	11.018315	10	10.006471	149.74
10.72	1295.937	11.0696	10.00324	10.17827	11.069597	10	10.006471	149.74

10.76	1289.719	11.11355	10.00324	10.12943	11.113553	10	10.006471	149.74
10.8	1282.256	11.14286	10.00324	10.07082	11.142857	10	10.006471	149.74
10.84	1276.038	11.16484	10.00324	10.02198	11.164835	10	10.006471	149.45
10.88	1273.55	11.20879	10.00324	10.00244	11.208791	10	10.006471	150.33
10.92	1269.819	11.22344	10.00324	9.97314	11.223443	10	10.006471	149.45
10.96	1269.819	11.24542	10.00324	9.97314	11.245421	10	10.006471	149.45
11	1274.794	11.28205	10.00324	10.01221	11.282051	10	10.006471	149.45
11.04	1277.282	11.31136	10.00324	10.03175	11.311355	10	10.006471	149.16
11.08	1282.256	11.36996	10.00324	10.07082	11.369963	10	10.006471	149.74
11.12	1281.013	11.42125	10.00324	10.06105	11.421245	10	10.006471	149.74
11.16	1276.038	11.48718	10.00324	10.02198	11.487179	10	10.006471	149.74
11.2	1269.819	11.54579	10.00324	9.97314	11.545788	10	10.006471	149.45
11.24	1259.87	11.58242	10.00324	9.89499	11.582418	10	10.006471	149.74
11.28	1252.408	11.62637	10.00324	9.83639	11.626374	10	10.006471	149.74
11.32	1246.189	11.64835	10.00324	9.78755	11.648352	10	10.006471	149.74
11.36	1243.702	11.68498	10.00324	9.76801	11.684982	10	10.006471	150.04
11.4	1239.971	11.69963	10.00324	9.73871	11.699634	10	10.006471	149.74
11.44	1243.702	11.72894	10.00324	9.76801	11.728938	10	10.006471	149.74
11.48	1246.189	11.76557	10.00324	9.78755	11.765568	10	10.006471	149.74
11.52	1252.408	11.79487	10.00324	9.83639	11.794872	10	10.006471	149.74
11.56	1256.139	11.84615	10.00324	9.86569	11.846154	10	10.006471	149.45
11.6	1253.651	11.89744	10.00324	9.84615	11.897436	10	10.006471	149.16
11.64	1248.676	11.9707	10.00324	9.80708	11.970696	10	10.006471	149.74
11.68	1238.727	12.04396	10.00324	9.72894	12.043956	10	10.006471	150.04
11.72	1226.29	12.08791	10.00324	9.63126	12.087912	10	10.006471	149.74
11.76	1217.584	12.13187	10.00324	9.56288	12.131868	10	10.006471	150.04
11.8	1210.122	12.15385	10.00324	9.50427	12.153846	10	10.006471	149.74
11.84	1205.147	12.17582	10.00324	9.4652	12.175824	10	10.006471	150.33
11.88	1201.416	12.19048	10.00324	9.4359	12.190476	10	10.006471	149.74
11.92	1201.416	12.21245	10.00324	9.4359	12.212454	10	10.006471	149.74
11.96	1206.391	12.23443	10.00324	9.47497	12.234432	10	10.006471	149.74
12	1213.853	12.26374	10.00324	9.53358	12.263736	10	10.006471	149.74
12.04	1221.315	12.29304	10.00324	9.59219	12.29304	10	10.006471	149.45
12.08	1227.534	12.35165	10.00324	9.64103	12.351648	10	10.006471	150.04
12.12	1227.534	12.41758	10.00324	9.64103	12.417582	10	10.006471	149.74
12.16	1221.315	12.49084	10.00324	9.59219	12.490842	10	10.006471	149.74
12.2	1212.609	12.54212	10.00324	9.52381	12.542125	10	10.006471	149.74
12.24	1202.659	12.60073	10.00324	9.44567	12.600733	10	10.006471	149.74
12.28	1193.954	12.63004	10.00324	9.37729	12.630037	10	10.006471	149.45
12.32	1191.466	12.69597	10.00324	9.35775	12.695971	10	10.006471	150.92
12.36	1181.517	12.68864	10.00324	9.27961	12.688645	10	10.006471	149.74
12.4	1176.542	12.7033	10.00324	9.24054	12.703297	10	10.006471	149.45
12.44	1176.542	12.73993	10.00324	9.24054	12.739927	10	10.006471	149.74
12.48	1177.785	12.74725	10.00324	9.25031	12.747253	10	10.006471	149.16
12.52	1185.248	12.78388	10.00324	9.30891	12.783883	10	10.006471	149.74
12.56	1192.71	12.82051	10.00324	9.36752	12.820513	10	10.006471	149.74
12.6	1197.685	12.87912	10.00324	9.40659	12.879121	10	10.006471	150.04
12.64	1196.441	12.93773	10.00324	9.39683	12.937729	10	10.006471	149.74
12.68	1190.222	13.01099	10.00324	9.34799	13.010989	10	10.006471	149.74
12.72	1177.785	13.07692	10.00324	9.25031	13.076923	10	10.006471	149.45
12.76	1166.592	13.12821	10.00324	9.16239	13.128205	10	10.006471	149.45
12.8	1160.374	13.16484	10.00324	9.11355	13.164835	10	10.006471	150.33
12.84	1151.668	13.19414	10.00324	9.04518	13.194139	10	10.006471	149.74
12.88	1147.937	13.21612	10.00324	9.01587	13.216117	10	10.006471	150.04
12.92	1144.206	13.22344	10.00324	8.98657	13.223443	10	10.006471	149.74
12.96	1144.206	13.24542	10.00324	8.98657	13.245421	10	10.006471	149.74
13	1149.18	13.2674	10.00324	9.02564	13.267399	10	10.006471	149.74
13.04	1157.886	13.2967	10.00324	9.09402	13.296703	10	10.006471	150.04
13.08	1166.592	13.33333	10.00324	9.16239	13.333333	10	10.006471	149.74
13.12	1170.323	13.39927	10.00324	9.1917	13.399267	10	10.006471	150.04
13.16	1166.592	13.47253	10.00324	9.16239	13.472527	10	10.006471	149.74
13.2	1157.886	13.53846	10.00324	9.09402	13.538462	10	10.006471	149.74
13.24	1152.911	13.62637	10.00324	9.05495	13.626374	10	10.006471	150.92
13.28	1137.987	13.64103	10.00324	8.93773	13.641026	10	10.006471	149.45
13.32	1130.525	13.65568	10.00324	8.87912	13.655678	10	10.006471	149.16
13.36	1126.794	13.68498	10.00324	8.84982	13.684982	10	10.006471	149.74
13.4	1128.037	13.71429	10.00324	8.85958	13.714286	10	10.006471	150.33
13.44	1125.55	13.72161	10.00324	8.84005	13.721612	10	10.006471	149.74
13.48	1130.525	13.74359	10.00324	8.87912	13.74359	10	10.006471	149.74
13.52	1137.987	13.77289	10.00324	8.93773	13.772894	10	10.006471	149.74
13.56	1146.693	13.81685	10.00324	9.00611	13.81685	10	10.006471	149.74
13.6	1151.668	13.87546	10.00324	9.04518	13.875458	10	10.006471	149.74
13.64	1149.18	13.94139	10.00324	9.02564	13.941392	10	10.006471	149.74
13.68	1140.474	14.02198	10.00324	8.95726	14.021978	10	10.006471	150.04
13.72	1129.281	14.07326	10.00324	8.86935	14.07326	10	10.006471	149.74
13.76	1120.575	14.11722	10.00324	8.80098	14.117216	10	10.006471	149.74
13.8	1111.869	14.14652	10.00324	8.7326	14.14652	10	10.006471	149.45
13.84	1106.894	14.1685	10.00324	8.69353	14.168498	10	10.006471	149.74
13.88	1104.407	14.19048	10.00324	8.67399	14.190476	10	10.006471	149.74
13.92	1103.163	14.21245	10.00324	8.66422	14.212454	10	10.006471	149.74
13.96	1105.651	14.21978	10.00324	8.68376	14.21978	10	10.006471	149.45
14	1114.357	14.26374	10.00324	8.75214	14.263736	10	10.006471	149.74
14.04	1119.331	14.29304	10.00324	8.79121	14.29304	10	10.006471	149.74
14.08	1126.794	14.35165	10.00324	8.84982	14.351648	10	10.006471	150.04
14.12	1128.037	14.41758	10.00324	8.85958	14.417582	10	10.006471	150.33
14.16	1121.819	14.48352	10.00324	8.81074	14.483516	10	10.006471	149.74
14.2	1113.113	14.54212	10.00324	8.74237	14.542125	10	10.006471	149.74
14.24	1103.163	14.57875	10.00324	8.66422	14.578755	10	10.006471	149.16

14.28	1098.189	14.63736	10.00324	8.62515	14.637363	10	10.006471	149.74
14.32	1090.726	14.65934	10.00324	8.56654	14.659341	10	10.006471	150.04
14.36	1085.752	14.68132	10.00324	8.52747	14.681319	10	10.006471	149.45
14.4	1084.508	14.7033	10.00324	8.5177	14.703297	10	10.006471	149.74
14.44	1084.508	14.72527	10.00324	8.5177	14.725275	10	10.006471	149.74
14.48	1089.483	14.74725	10.00324	8.55678	14.747253	10	10.006471	150.04
14.52	1095.701	14.76923	10.00324	8.60562	14.769231	10	10.006471	149.45
14.56	1105.651	14.82784	10.00324	8.68376	14.827839	10	10.006471	150.62
14.6	1106.894	14.87179	10.00324	8.69353	14.871795	10	10.006471	149.74
14.64	1108.138	14.95238	10.00324	8.7033	14.952381	10	10.006471	150.33
14.68	1100.676	15.01099	10.00324	8.64469	15.010989	10	10.006471	149.74
14.72	1089.483	15.07692	10.00324	8.55678	15.076923	10	10.006471	149.16
14.76	1080.777	15.12088	10.00324	8.4884	15.120879	10	10.006471	150.04
14.8	1075.802	15.16484	10.00324	8.44933	15.164835	10	10.006471	150.04
14.84	1068.34	15.17216	10.00324	8.39072	15.172161	10	10.006471	149.74
14.88	1067.096	15.20147	10.00324	8.38095	15.201465	10	10.006471	150.04
14.92	1063.365	15.21612	10.00324	8.35165	15.216117	10	10.006471	149.74
14.96	1064.609	15.23077	10.00324	8.36142	15.230769	10	10.006471	149.16
15	1072.071	15.2674	10.00324	8.42002	15.267399	10	10.006471	149.74
15.04	1078.289	15.2967	10.00324	8.46886	15.296703	10	10.006471	149.74
15.08	1084.508	15.34799	10.00324	8.5177	15.347985	10	10.006471	149.74
15.12	1084.508	15.41392	10.00324	8.5177	15.413919	10	10.006471	149.74
15.16	1078.289	15.49451	10.00324	8.46886	15.494505	10	10.006471	150.04
15.2	1067.096	15.55311	10.00324	8.38095	15.553114	10	10.006471	149.74
15.24	1057.146	15.59707	10.00324	8.30281	15.59707	10	10.006471	149.74
15.28	1052.172	15.62637	10.00324	8.26374	15.626374	10	10.006471	149.74
15.32	1047.197	15.64835	10.00324	8.22466	15.648352	10	10.006471	149.74
15.36	1044.709	15.663	10.00324	8.20513	15.663004	10	10.006471	149.74
15.4	1048.44	15.70696	10.00324	8.23443	15.70696	10	10.006471	150.92
15.44	1048.44	15.69963	10.00324	8.23443	15.699634	10	10.006471	149.74
15.48	1055.903	15.72894	10.00324	8.29304	15.728938	10	10.006471	149.74
15.52	1064.609	15.76557	10.00324	8.36142	15.765568	10	10.006471	149.74
15.56	1069.583	15.8315	10.00324	8.40049	15.831502	10	10.006471	150.04
15.6	1067.096	15.90476	10.00324	8.38095	15.904762	10	10.006471	149.74
15.64	1062.121	15.98535	10.00324	8.34188	15.985348	10	10.006471	150.33
15.68	1052.172	16.02198	10.00324	8.26374	16.021978	10	10.006471	150.04
15.72	1042.222	16.05128	10.00324	8.18559	16.051282	10	10.006471	148.86
15.76	1039.735	16.08791	10.00324	8.16606	16.087912	10	10.006471	149.74
15.8	1033.516	16.08791	10.00324	8.11722	16.087912	10	10.006471	148.57
15.84	1036.003	16.12454	10.00324	8.13675	16.124542	10	10.006471	149.74
15.88	1038.491	16.14652	10.00324	8.15629	16.14652	10	10.006471	149.74
15.92	1044.709	16.17582	10.00324	8.20513	16.175824	10	10.006471	149.74
15.96	1052.172	16.21978	10.00324	8.26374	16.21978	10	10.006471	150.04
16	1053.415	16.27839	10.00324	8.2735	16.278388	10	10.006471	149.74
16.04	1049.684	16.3663	10.00324	8.2442	16.3663	10	10.006471	150.04
16.08	1038.491	16.42491	10.00324	8.15629	16.424908	10	10.006471	149.74
16.12	1028.541	16.46886	10.00324	8.07814	16.468864	10	10.006471	149.45
16.16	1021.079	16.49817	10.00324	8.01954	16.498168	10	10.006471	149.45
16.2	1017.348	16.52747	10.00324	7.99023	16.527473	10	10.006471	150.04
16.24	1013.617	16.54945	10.00324	7.96093	16.549451	10	10.006471	149.74
16.28	1013.617	16.5641	10.00324	7.96093	16.564103	10	10.006471	149.74
16.32	1016.104	16.58608	10.00324	7.98046	16.586081	10	10.006471	149.74
16.36	1024.81	16.60806	10.00324	8.04884	16.608059	10	10.006471	150.04
16.4	1038.491	16.67399	10.00324	8.15629	16.673993	10	10.006471	151.5
16.44	1037.247	16.69597	10.00324	8.14652	16.695971	10	10.006471	149.74
16.48	1039.735	16.78388	10.00324	8.16606	16.783883	10	10.006471	150.33
16.52	1028.541	16.84249	10.00324	8.07814	16.842491	10	10.006471	149.74
16.56	1018.592	16.91575	10.00324	8	16.915751	10	10.006471	150.33
16.6	1009.886	16.95238	10.00324	7.93162	16.952381	10	10.006471	149.74
16.64	1001.18	16.97436	10.00324	7.86325	16.974359	10	10.006471	149.74
16.68	997.449	16.99634	10.00324	7.83394	16.996337	10	10.006471	149.74
16.72	994.961	17.01832	10.00324	7.81441	17.018315	10	10.006471	149.74
16.76	994.961	17.03297	10.00324	7.81441	17.032967	10	10.006471	149.74
16.8	998.692	17.05495	10.00324	7.84371	17.054945	10	10.006471	149.74
16.84	1007.398	17.08425	10.00324	7.91209	17.084249	10	10.006471	150.04
16.88	1013.617	17.0989	10.00324	7.96093	17.098901	10	10.006471	148.86
16.92	1022.323	17.17216	10.00324	8.0293	17.172161	10	10.006471	149.74
16.96	1022.323	17.24542	10.00324	8.0293	17.245421	10	10.006471	149.74
17	1013.617	17.31868	10.00324	7.96093	17.318681	10	10.006471	149.74
17.04	1007.398	17.38462	10.00324	7.91209	17.384615	10	10.006471	149.74
17.08	998.692	17.42125	10.00324	7.84371	17.421245	10	10.006471	149.74
17.12	991.23	17.45055	10.00324	7.7851	17.450549	10	10.006471	149.74
17.16	989.986	17.49451	10.00324	7.77534	17.494505	10	10.006471	150.92
17.2	983.768	17.49451	10.00324	7.7265	17.494505	10	10.006471	149.74
17.24	983.768	17.52381	10.00324	7.7265	17.52381	10	10.006471	150.04
17.28	985.012	17.53846	10.00324	7.73626	17.538462	10	10.006471	149.74
17.32	988.743	17.57509	10.00324	7.76557	17.575092	10	10.006471	149.74
17.36	994.961	17.61172	10.00324	7.81441	17.611722	10	10.006471	149.74
17.4	997.449	17.663	10.00324	7.83394	17.663004	10	10.006471	149.45
17.44	996.205	17.72161	10.00324	7.82418	17.721612	10	10.006471	149.74
17.48	992.474	17.79487	10.00324	7.79487	17.794872	10	10.006471	150.33
17.52	983.768	17.84615	10.00324	7.7265	17.846154	10	10.006471	149.74
17.56	976.306	17.89011	10.00324	7.66789	17.89011	10	10.006471	149.74
17.6	970.087	17.91941	10.00324	7.61905	17.919414	10	10.006471	150.04
17.64	965.112	17.94139	10.00324	7.57998	17.941392	10	10.006471	149.74
17.68	962.625	17.9707	10.00324	7.56044	17.970696	10	10.006471	149.74
17.72	965.112	17.99267	10.00324	7.57998	17.992674	10	10.006471	149.74
17.76	967.6	18.00733	10.00324	7.59951	18.007326	10	10.006471	149.74

17.8	975.062	18.03663	10.00324	7.65812	18.03663	10	10.006471	149.74
17.84	978.793	18.07326	10.00324	7.68742	18.07326	10	10.006471	149.16
17.88	985.012	18.14652	10.00324	7.73626	18.14652	10	10.006471	150.04
17.92	980.037	18.21245	10.00324	7.69719	18.212454	10	10.006471	149.74
17.96	973.818	18.27839	10.00324	7.64835	18.278388	10	10.006471	149.74
18	967.6	18.34432	10.00324	7.59951	18.344322	10	10.006471	150.62
18.04	958.894	18.37363	10.00324	7.53114	18.373626	10	10.006471	149.74
18.08	955.163	18.40293	10.00324	7.50183	18.40293	10	10.006471	150.33
18.12	948.944	18.41026	10.00324	7.45299	18.410256	10	10.006471	149.74
18.16	948.944	18.43223	10.00324	7.45299	18.432234	10	10.006471	149.74
18.2	952.675	18.45421	10.00324	7.4823	18.454212	10	10.006471	149.74
18.24	957.65	18.47619	10.00324	7.52137	18.47619	10	10.006471	149.16
18.28	966.356	18.51282	10.00324	7.58974	18.512821	10	10.006471	149.74
18.32	971.331	18.57143	10.00324	7.62882	18.571429	10	10.006471	149.74
18.36	970.087	18.64469	10.00324	7.61905	18.644689	10	10.006471	149.74
18.4	962.625	18.71795	10.00324	7.56044	18.717949	10	10.006471	149.74
18.44	951.432	18.77656	10.00324	7.47253	18.776557	10	10.006471	149.45
18.48	938.995	18.83516	10.00324	7.37485	18.835165	10	10.006471	149.74
18.52	930.289	18.86447	10.00324	7.30647	18.864469	10	10.006471	149.74
18.56	920.339	18.87179	10.00324	7.22833	18.871795	10	10.006471	149.16
18.6	917.852	18.9011	10.00324	7.20879	18.901099	10	10.006471	149.45
18.64	925.314	18.96703	10.00324	7.2674	18.967033	10	10.006471	152.09
18.68	917.852	18.93773	10.00324	7.20879	18.937729	10	10.006471	149.74
18.72	922.827	18.95971	10.00324	7.24786	18.959707	10	10.006471	150.04
18.76	931.533	18.98168	10.00324	7.31624	18.981685	10	10.006471	149.45
18.8	942.726	19.05495	10.00324	7.40415	19.054945	10	10.006471	150.92
18.84	937.751	19.12088	10.00324	7.36508	19.120879	10	10.006471	149.74
18.88	924.07	19.20147	10.00324	7.25763	19.201465	10	10.006471	149.45
18.92	911.633	19.2674	10.00324	7.15995	19.267399	10	10.006471	149.74
18.96	897.953	19.2967	10.00324	7.0525	19.296703	10	10.006471	149.16
19	891.734	19.33333	10.00324	7.00366	19.333333	10	10.006471	149.74
19.04	886.759	19.34799	10.00324	6.96459	19.347985	10	10.006471	149.74
19.08	885.516	19.38462	10.00324	6.95482	19.384615	10	10.006471	150.62
19.12	883.028	19.38462	10.00324	6.93529	19.384615	10	10.006471	149.74
19.16	886.759	19.39927	10.00324	6.96459	19.399267	10	10.006471	149.74
19.2	895.465	19.42125	10.00324	7.03297	19.421245	10	10.006471	150.04
19.24	905.415	19.45055	10.00324	7.11111	19.450549	10	10.006471	149.74
19.28	911.633	19.51648	10.00324	7.15995	19.516484	10	10.006471	150.04
19.32	901.684	19.58242	10.00324	7.08181	19.582418	10	10.006471	148.57
19.36	894.221	19.69231	10.00324	7.0232	19.692308	10	10.006471	149.74
19.4	883.028	19.74359	10.00324	6.93529	19.74359	10	10.006471	149.74
19.44	873.079	19.77289	10.00324	6.85714	19.772894	10	10.006471	149.74
19.48	865.616	19.78755	10.00324	6.79853	19.787546	10	10.006471	149.45
19.52	863.129	19.80952	10.00324	6.779	19.809524	10	10.006471	149.74
19.56	861.885	19.8315	10.00324	6.76923	19.831502	10	10.006471	149.74
19.6	864.373	19.84615	10.00324	6.78877	19.846154	10	10.006471	150.04
19.64	869.347	19.86813	10.00324	6.82784	19.868132	10	10.006471	149.74
19.68	876.81	19.88278	10.00324	6.88645	19.882784	10	10.006471	149.16
19.72	886.759	19.94872	10.00324	6.96459	19.948718	10	10.006471	149.74
19.76	888.003	20.0293	10.00324	6.97436	20.029304	10	10.006471	150.33
19.8	879.297	20.10256	10.00324	6.90598	20.102564	10	10.006471	149.74
19.84	870.591	20.17582	10.00324	6.83761	20.175824	10	10.006471	150.33
19.88	860.642	20.20513	10.00324	6.75946	20.205128	10	10.006471	149.74
19.92	854.423	20.22711	10.00324	6.71062	20.227106	10	10.006471	149.74
19.96	851.936	20.24908	10.00324	6.69109	20.249084	10	10.006471	149.74
20	851.936	20.26374	10.00324	6.69109	20.263736	10	10.006471	149.74
20.04	854.423	20.27839	10.00324	6.71062	20.278388	10	10.006471	149.74
20.08	861.885	20.30037	10.00324	6.76923	20.300366	10	10.006471	149.45
20.12	871.835	20.34432	10.00324	6.84737	20.344322	10	10.006471	149.74
20.16	875.566	20.40293	10.00324	6.87668	20.40293	10	10.006471	150.04
20.2	870.591	20.47619	10.00324	6.83761	20.47619	10	10.006471	149.45
20.24	861.885	20.55678	10.00324	6.76923	20.556777	10	10.006471	149.74
20.28	854.423	20.60073	10.00324	6.71062	20.600733	10	10.006471	149.74
20.32	849.448	20.63004	10.00324	6.67155	20.630037	10	10.006471	149.74
20.36	845.717	20.64469	10.00324	6.64225	20.644689	10	10.006471	149.74
20.4	845.717	20.65934	10.00324	6.64225	20.659341	10	10.006471	149.74
20.44	845.717	20.68132	10.00324	6.64225	20.681319	10	10.006471	149.74
20.48	854.423	20.7326	10.00324	6.71062	20.732601	10	10.006471	150.33
20.52	859.398	20.74725	10.00324	6.74969	20.747253	10	10.006471	149.74
20.56	861.885	20.79853	10.00324	6.76923	20.798535	10	10.006471	149.74
20.6	859.398	20.87912	10.00324	6.74969	20.879121	10	10.006471	149.74
20.64	851.936	20.94505	10.00324	6.69109	20.945055	10	10.006471	149.74
20.68	844.473	20.99634	10.00324	6.63248	20.996337	10	10.006471	149.74
20.72	838.255	21.02564	10.00324	6.58364	21.025641	10	10.006471	149.74
20.76	834.524	21.05495	10.00324	6.55433	21.054945	10	10.006471	149.74
20.8	832.036	21.0696	10.00324	6.5348	21.069597	10	10.006471	149.74
20.84	833.28	21.09158	10.00324	6.54457	21.091575	10	10.006471	149.74
20.88	839.499	21.10623	10.00324	6.59341	21.106227	10	10.006471	149.74
20.92	846.961	21.14286	10.00324	6.65201	21.142857	10	10.006471	149.74
20.96	853.179	21.19414	10.00324	6.70085	21.194139	10	10.006471	149.74
21	850.692	21.2674	10.00324	6.68132	21.267399	10	10.006471	149.74
21.04	843.23	21.34799	10.00324	6.62271	21.347985	10	10.006471	149.74
21.08	833.28	21.39927	10.00324	6.54457	21.399267	10	10.006471	149.74
21.12	827.062	21.42857	10.00324	6.49573	21.428571	10	10.006471	149.74
21.16	823.33	21.45788	10.00324	6.46642	21.457875	10	10.006471	149.74
21.2	822.087	21.47985	10.00324	6.45665	21.479853	10	10.006471	150.04
21.24	823.33	21.48718	10.00324	6.46642	21.487179	10	10.006471	149.74
21.28	829.549	21.50916	10.00324	6.51526	21.509158	10	10.006471	149.74

21.32	838.255	21.54579	10.00324	6.58364	21.545788	10	10.006471	150.33
21.36	843.23	21.58974	10.00324	6.62271	21.589744	10	10.006471	150.04
21.4	840.742	21.67033	10.00324	6.60317	21.67033	10	10.006471	149.74
21.44	832.036	21.75092	10.00324	6.5348	21.750916	10	10.006471	149.74
21.48	822.087	21.8022	10.00324	6.45665	21.802198	10	10.006471	149.74
21.52	817.112	21.8315	10.00324	6.41758	21.831502	10	10.006471	149.74
21.56	812.137	21.84615	10.00324	6.37851	21.846154	10	10.006471	149.45
21.6	810.893	21.86813	10.00324	6.36874	21.868132	10	10.006471	149.74
21.64	812.137	21.88278	10.00324	6.37851	21.882784	10	10.006471	149.74
21.68	818.356	21.90476	10.00324	6.42735	21.904762	10	10.006471	149.74
21.72	825.818	21.94139	10.00324	6.48596	21.941392	10	10.006471	149.74
21.76	832.036	21.99267	10.00324	6.5348	21.992674	10	10.006471	149.74
21.8	833.28	22.06593	10.00324	6.54457	22.065934	10	10.006471	150.04
21.84	825.818	22.12454	10.00324	6.48596	22.124542	10	10.006471	149.74
21.88	815.868	22.1685	10.00324	6.40781	22.168498	10	10.006471	148.86
21.92	812.137	22.22711	10.00324	6.37851	22.227106	10	10.006471	149.74
21.96	805.919	22.25641	10.00324	6.32967	22.25641	10	10.006471	149.74
22	803.431	22.28571	10.00324	6.31013	22.285714	10	10.006471	149.74
22.04	800.944	22.30037	10.00324	6.2906	22.300366	10	10.006471	149.45
22.08	802.188	22.32234	10.00324	6.30037	22.322344	10	10.006471	149.74
22.12	809.65	22.34432	10.00324	6.35897	22.344322	10	10.006471	149.74
22.16	814.625	22.38828	10.00324	6.39805	22.388278	10	10.006471	150.04
22.2	815.868	22.44689	10.00324	6.40781	22.446886	10	10.006471	149.74
22.24	807.162	22.50549	10.00324	6.33944	22.505495	10	10.006471	149.16
22.28	798.456	22.59341	10.00324	6.27106	22.593407	10	10.006471	149.74
22.32	787.263	22.63004	10.00324	6.18315	22.630037	10	10.006471	149.16
22.36	779.801	22.66667	10.00324	6.12454	22.666667	10	10.006471	149.45
22.4	774.826	22.69597	10.00324	6.08547	22.695971	10	10.006471	149.74
22.44	773.582	22.71062	10.00324	6.0757	22.710623	10	10.006471	149.74
22.48	774.826	22.71795	10.00324	6.08547	22.717949	10	10.006471	149.74
22.52	781.045	22.73993	10.00324	6.13431	22.739927	10	10.006471	149.74
22.56	789.751	22.7619	10.00324	6.20269	22.761905	10	10.006471	149.74
22.6	794.725	22.80586	10.00324	6.24176	22.805861	10	10.006471	148.86
22.64	797.213	22.89377	10.00324	6.26129	22.893773	10	10.006471	149.74
22.68	789.751	22.97436	10.00324	6.20269	22.974359	10	10.006471	150.04
22.72	779.801	23.02564	10.00324	6.12454	23.025641	10	10.006471	149.45
22.76	774.826	23.05495	10.00324	6.08547	23.054945	10	10.006471	149.74
22.8	769.851	23.07692	10.00324	6.0464	23.076923	10	10.006471	149.74
22.84	769.851	23.0989	10.00324	6.0464	23.098901	10	10.006471	149.74
22.88	771.095	23.12088	10.00324	6.05617	23.120879	10	10.006471	149.74
22.92	777.314	23.14286	10.00324	6.10501	23.142857	10	10.006471	149.74
22.96	784.776	23.17949	10.00324	6.16361	23.179487	10	10.006471	149.74
23	788.507	23.2381	10.00324	6.19292	23.238095	10	10.006471	149.74
23.04	787.263	23.28938	10.00324	6.18315	23.289377	10	10.006471	149.45
23.08	786.019	23.34799	10.00324	6.17338	23.347985	10	10.006471	149.74
23.12	781.045	23.39194	10.00324	6.13431	23.391941	10	10.006471	149.45
23.16	774.826	23.41392	10.00324	6.08547	23.413919	10	10.006471	149.16
23.2	774.826	23.45788	10.00324	6.08547	23.457875	10	10.006471	149.74
23.24	769.851	23.47253	10.00324	6.0464	23.472527	10	10.006471	148.57
23.28	776.07	23.52381	10.00324	6.09524	23.52381	10	10.006471	149.45
23.32	781.045	23.55311	10.00324	6.13431	23.553114	10	10.006471	149.74
23.36	786.019	23.59707	10.00324	6.17338	23.59707	10	10.006471	149.74
23.4	789.751	23.64835	10.00324	6.20269	23.648352	10	10.006471	150.04
23.44	790.994	23.70696	10.00324	6.21245	23.70696	10	10.006471	149.74
23.48	788.507	23.75092	10.00324	6.19292	23.750916	10	10.006471	149.74
23.52	783.532	23.8022	10.00324	6.15385	23.802198	10	10.006471	149.74
23.56	779.801	23.8315	10.00324	6.12454	23.831502	10	10.006471	149.74
23.6	778.557	23.86813	10.00324	6.11477	23.868132	10	10.006471	149.74
23.64	777.314	23.89011	10.00324	6.10501	23.89011	10	10.006471	149.74
23.68	779.801	23.91941	10.00324	6.12454	23.919414	10	10.006471	149.74
23.72	783.532	23.94139	10.00324	6.15385	23.941392	10	10.006471	149.16
23.76	789.751	24	10.00324	6.20269	24	10	10.006471	149.74
23.8	790.994	24.05861	10.00324	6.21245	24.058608	10	10.006471	150.04
23.84	787.263	24.11722	10.00324	6.18315	24.117216	10	10.006471	150.04
23.88	781.045	24.16117	10.00324	6.13431	24.161172	10	10.006471	149.45
23.92	777.314	24.20513	10.00324	6.10501	24.205128	10	10.006471	149.45
23.96	772.339	24.22711	10.00324	6.06593	24.227106	10	10.006471	149.45
24	776.07	24.27106	10.00324	6.09524	24.271062	10	10.006471	150.33
24.04	773.582	24.28571	10.00324	6.0757	24.285714	10	10.006471	149.74
24.08	777.314	24.31502	10.00324	6.10501	24.315018	10	10.006471	149.74
24.12	783.532	24.35897	10.00324	6.15385	24.358974	10	10.006471	150.33
24.16	786.019	24.40293	10.00324	6.17338	24.40293	10	10.006471	149.74
24.2	786.019	24.45421	10.00324	6.17338	24.454212	10	10.006471	149.74
24.24	783.532	24.52015	10.00324	6.15385	24.520147	10	10.006471	150.04
24.28	778.557	24.54945	10.00324	6.11477	24.549451	10	10.006471	149.45
24.32	776.07	24.59341	10.00324	6.09524	24.593407	10	10.006471	149.74
24.36	773.582	24.62271	10.00324	6.0757	24.622711	10	10.006471	149.74
24.4	773.582	24.64469	10.00324	6.0757	24.644689	10	10.006471	149.74
24.44	776.07	24.68132	10.00324	6.09524	24.681319	10	10.006471	149.74
24.48	778.557	24.72527	10.00324	6.11477	24.725275	10	10.006471	149.74
24.52	782.288	24.7619	10.00324	6.14408	24.761905	10	10.006471	149.74
24.56	782.288	24.81319	10.00324	6.14408	24.813187	10	10.006471	149.74
24.6	781.045	24.86447	10.00324	6.13431	24.864469	10	10.006471	149.74
24.64	777.314	24.92308	10.00324	6.10501	24.923077	10	10.006471	149.74
24.68	774.826	24.95971	10.00324	6.08547	24.959707	10	10.006471	150.33
24.72	769.851	24.98901	10.00324	6.0464	24.989011	10	10.006471	149.74
24.76	774.826	25.04762	10.00324	6.08547	25.047619	10	10.006471	151.5
24.8	769.851	25.04029	10.00324	6.0464	25.040293	10	10.006471	149.74

24.84	774.826	25.06227	10.00324	6.08547	25.062271	10	10.006471	149.74
24.88	781.045	25.11355	10.00324	6.13431	25.113553	10	10.006471	150.04
24.92	782.288	25.16484	10.00324	6.14408	25.164835	10	10.006471	149.74
24.96	781.045	25.22344	10.00324	6.13431	25.223443	10	10.006471	149.74
25	777.314	25.27473	10.00324	6.10501	25.274725	10	10.006471	150.04
25.04	771.095	25.31136	10.00324	6.05617	25.311355	10	10.006471	149.74
25.08	768.608	25.34066	10.00324	6.03663	25.340659	10	10.006471	149.74
25.12	767.364	25.36264	10.00324	6.02686	25.362637	10	10.006471	149.16
25.16	768.608	25.37729	10.00324	6.03663	25.377289	10	10.006471	149.16
25.2	776.07	25.42857	10.00324	6.09524	25.428571	10	10.006471	149.74
25.24	781.045	25.47253	10.00324	6.13431	25.472527	10	10.006471	149.74
25.28	782.288	25.52381	10.00324	6.14408	25.52381	10	10.006471	149.74
25.32	781.045	25.58242	10.00324	6.13431	25.582418	10	10.006471	149.74
25.36	779.801	25.64103	10.00324	6.12454	25.641026	10	10.006471	150.92
25.4	773.582	25.67033	10.00324	6.0757	25.67033	10	10.006471	149.45
25.44	772.339	25.70696	10.00324	6.06593	25.70696	10	10.006471	150.33
25.48	768.608	25.72894	10.00324	6.03663	25.728938	10	10.006471	149.74
25.52	769.851	25.76557	10.00324	6.0464	25.765568	10	10.006471	149.74
25.56	771.095	25.78755	10.00324	6.05617	25.787546	10	10.006471	149.16
25.6	776.07	25.8315	10.00324	6.09524	25.831502	10	10.006471	149.74
25.64	778.557	25.87546	10.00324	6.11477	25.875458	10	10.006471	149.74
25.68	778.557	25.92674	10.00324	6.11477	25.92674	10	10.006471	149.74
25.72	777.314	25.97802	10.00324	6.10501	25.978022	10	10.006471	150.04
25.76	774.826	26.02198	10.00324	6.08547	26.021978	10	10.006471	149.74
25.8	771.095	26.06593	10.00324	6.05617	26.065934	10	10.006471	149.74
25.84	766.12	26.08791	10.00324	6.01709	26.087912	10	10.006471	149.16
25.88	766.12	26.12454	10.00324	6.01709	26.124542	10	10.006471	149.74
25.92	768.608	26.15385	10.00324	6.03663	26.153846	10	10.006471	149.74
25.96	773.582	26.21245	10.00324	6.0757	26.212454	10	10.006471	150.33
26	771.095	26.23443	10.00324	6.05617	26.234432	10	10.006471	149.74
26.04	772.339	26.31502	10.00324	6.06593	26.315018	10	10.006471	150.33
26.08	764.877	26.34432	10.00324	6.00733	26.344322	10	10.006471	149.74
26.12	761.145	26.38095	10.00324	5.97802	26.380952	10	10.006471	149.74
26.16	758.658	26.41026	10.00324	5.95849	26.410256	10	10.006471	149.74
26.2	757.414	26.43956	10.00324	5.94872	26.43956	10	10.006471	150.04
26.24	759.902	26.46886	10.00324	5.96825	26.468864	10	10.006471	149.74
26.28	764.877	26.50549	10.00324	6.00733	26.505495	10	10.006471	149.74
26.32	766.12	26.55678	10.00324	6.01709	26.556777	10	10.006471	149.74
26.36	763.633	26.61538	10.00324	5.99756	26.615385	10	10.006471	149.74
26.4	758.658	26.65934	10.00324	5.95849	26.659341	10	10.006471	149.74
26.44	754.927	26.69597	10.00324	5.92918	26.695971	10	10.006471	149.74
26.48	753.683	26.72527	10.00324	5.91941	26.725275	10	10.006471	149.74
26.52	756.171	26.75458	10.00324	5.93895	26.754579	10	10.006471	149.74
26.56	759.902	26.77656	10.00324	5.96825	26.776557	10	10.006471	149.45
26.6	766.12	26.82051	10.00324	6.01709	26.820513	10	10.006471	149.74
26.64	769.851	26.87912	10.00324	6.0464	26.879121	10	10.006471	149.74
26.68	767.364	26.93773	10.00324	6.02686	26.937729	10	10.006471	149.74
26.72	758.658	26.97436	10.00324	5.95849	26.974359	10	10.006471	149.16
26.76	757.414	27.01832	10.00324	5.94872	27.018315	10	10.006471	149.74
26.8	754.927	27.05495	10.00324	5.92918	27.054945	10	10.006471	149.74
26.84	756.171	27.07692	10.00324	5.93895	27.076923	10	10.006471	149.74
26.88	759.902	27.10623	10.00324	5.96825	27.106227	10	10.006471	149.74
26.92	767.364	27.14286	10.00324	6.02686	27.142857	10	10.006471	149.74
26.96	767.364	27.19414	10.00324	6.02686	27.194139	10	10.006471	149.74
27	762.389	27.26007	10.00324	5.98779	27.260073	10	10.006471	149.74
27.04	759.902	27.2967	10.00324	5.96825	27.296703	10	10.006471	150.04
27.08	753.683	27.31868	10.00324	5.91941	27.318681	10	10.006471	149.74
27.12	753.683	27.35531	10.00324	5.91941	27.355311	10	10.006471	149.74
27.16	754.927	27.38462	10.00324	5.92918	27.384615	10	10.006471	149.74
27.2	759.902	27.42125	10.00324	5.96825	27.421245	10	10.006471	149.74
27.24	763.633	27.47253	10.00324	5.99756	27.472527	10	10.006471	149.74
27.28	758.658	27.53114	10.00324	5.95849	27.531136	10	10.006471	149.45
27.32	752.439	27.58242	10.00324	5.90965	27.582418	10	10.006471	149.74
27.36	747.465	27.61905	10.00324	5.87057	27.619048	10	10.006471	149.74
27.4	746.221	27.64103	10.00324	5.86081	27.641026	10	10.006471	149.74
27.44	747.465	27.67033	10.00324	5.87057	27.67033	10	10.006471	149.74
27.48	753.683	27.69963	10.00324	5.91941	27.699634	10	10.006471	150.04
27.52	757.414	27.73626	10.00324	5.94872	27.736264	10	10.006471	149.74
27.56	759.902	27.78755	10.00324	5.96825	27.787546	10	10.006471	149.74
27.6	757.414	27.84615	10.00324	5.94872	27.846154	10	10.006471	149.74
27.64	757.414	27.90476	10.00324	5.94872	27.904762	10	10.006471	150.62
27.68	749.952	27.93407	10.00324	5.89011	27.934066	10	10.006471	149.74
27.72	747.465	27.9707	10.00324	5.87057	27.970696	10	10.006471	150.33
27.76	746.221	27.99267	10.00324	5.86081	27.992674	10	10.006471	149.74
27.8	748.708	28.02198	10.00324	5.88034	28.021978	10	10.006471	149.74
27.84	753.683	28.05861	10.00324	5.91941	28.058608	10	10.006471	149.74
27.88	757.414	28.10256	10.00324	5.94872	28.102564	10	10.006471	150.04
27.92	758.658	28.16117	10.00324	5.95849	28.161172	10	10.006471	149.74
27.96	753.683	28.21978	10.00324	5.91941	28.21978	10	10.006471	149.74
28	747.465	28.25641	10.00324	5.87057	28.25641	10	10.006471	149.74
28.04	743.734	28.29304	10.00324	5.84127	28.29304	10	10.006471	149.74
28.08	741.246	28.32234	10.00324	5.82173	28.322344	10	10.006471	149.74
28.12	742.49	28.34432	10.00324	5.8315	28.344322	10	10.006471	149.74
28.16	747.465	28.37363	10.00324	5.87057	28.373626	10	10.006471	149.74
28.2	751.196	28.41758	10.00324	5.89988	28.417582	10	10.006471	149.74
28.24	752.439	28.47619	10.00324	5.90965	28.47619	10	10.006471	149.74
28.28	748.708	28.52747	10.00324	5.88034	28.527473	10	10.006471	149.74
28.32	744.977	28.58608	10.00324	5.85104	28.586081	10	10.006471	150.33

28.36	738.759	28.60806	10.00324	5.8022	28.608059	10	10.006471	149.74
28.4	737.515	28.63004	10.00324	5.79243	28.630037	10	10.006471	149.74
28.44	737.515	28.65934	10.00324	5.79243	28.659341	10	10.006471	149.16
28.48	743.734	28.68864	10.00324	5.84127	28.688645	10	10.006471	149.74
28.52	747.465	28.73993	10.00324	5.87057	28.739927	10	10.006471	149.74
28.56	748.708	28.79853	10.00324	5.88034	28.798535	10	10.006471	149.74
28.6	743.734	28.84982	10.00324	5.84127	28.849817	10	10.006471	149.74
28.64	740.002	28.89377	10.00324	5.81197	28.893773	10	10.006471	149.74
28.68	733.784	28.92308	10.00324	5.76313	28.923077	10	10.006471	149.74
28.72	733.784	28.95238	10.00324	5.76313	28.952381	10	10.006471	149.74
28.76	737.515	29.00366	10.00324	5.79243	29.003663	10	10.006471	150.33
28.8	738.759	29.01832	10.00324	5.8022	29.018315	10	10.006471	149.74
28.84	741.246	29.05495	10.00324	5.82173	29.054945	10	10.006471	149.74
28.88	742.49	29.11355	10.00324	5.8315	29.113553	10	10.006471	149.74
28.92	740.002	29.15751	10.00324	5.81197	29.157509	10	10.006471	149.45
28.96	737.515	29.21612	10.00324	5.79243	29.216117	10	10.006471	150.04
29	733.784	29.24542	10.00324	5.76313	29.245421	10	10.006471	150.04
29.04	728.809	29.28205	10.00324	5.72405	29.282051	10	10.006471	150.33
29.08	718.86	29.28205	10.00324	5.64591	29.282051	10	10.006471	149.74
29.12	713.885	29.28938	10.00324	5.60684	29.289377	10	10.006471	149.74
29.16	707.666	29.2967	10.00324	5.558	29.296703	10	10.006471	149.74
29.2	705.179	29.30403	10.00324	5.53846	29.304029	10	10.006471	149.74
29.24	700.204	29.30403	10.00324	5.49939	29.304029	10	10.006471	149.74
29.28	696.473	29.31136	10.00324	5.47009	29.311355	10	10.006471	149.74
29.32	692.742	29.31136	10.00324	5.44078	29.311355	10	10.006471	149.74
29.36	691.498	29.31136	10.00324	5.43101	29.311355	10	10.006471	149.74
29.4	687.767	29.31136	10.00324	5.40171	29.311355	10	10.006471	149.74
29.44	684.036	29.31868	10.00324	5.37241	29.318681	10	10.006471	149.74
29.48	681.548	29.30403	10.00324	5.35287	29.304029	10	10.006471	149.74
29.52	679.061	29.31136	10.00324	5.33333	29.311355	10	10.006471	149.74
29.56	676.574	29.31136	10.00324	5.3138	29.311355	10	10.006471	149.74
29.6	675.33	29.31868	10.00324	5.30403	29.318681	10	10.006471	149.74
29.64	672.843	29.31136	10.00324	5.28449	29.311355	10	10.006471	149.74
29.68	669.111	29.2967	10.00324	5.25519	29.296703	10	10.006471	149.16
29.72	667.868	29.31136	10.00324	5.24542	29.311355	10	10.006471	149.74
29.76	666.624	29.31136	10.00324	5.23565	29.311355	10	10.006471	149.45
29.8	664.137	29.31868	10.00324	5.21612	29.318681	10	10.006471	150.33
29.84	659.162	29.30403	10.00324	5.17705	29.304029	10	10.006471	149.74
29.88	651.7	29.28938	10.00324	5.11844	29.289377	10	10.006471	149.16
29.92	647.969	29.30403	10.00324	5.08913	29.304029	10	10.006471	149.74
29.96	641.75	29.30403	10.00324	5.04029	29.304029	10	10.006471	149.74
30	630.557	29.28205	10.00324	4.95238	29.282051	10	10.006471	149.16

Multistage triaxial test : Washed and carbonated red sand

SOIL MECHANIC LABORATORY CURTIN UNIVERSITY OF TECHNOLOGY

Triaxial Consolidation

Project:	PhD Project	Source of Soil:	Kwinana Refinery,WA		test type: CU, CD, C-QU, PERM.			
Location:	Curtin University of Technology	tested Date:			Specimen type:			
Soil Description:	Washed&Carbonated red sand	Test By:	Mr.Peerapong Jitsangiam		**Undisturbed, Remoulded, Recompacted**			
Remark:		Effective Pressure		kPa	no. of membrane	1		
		Cell Pressure		kPa	Membrane thinkness	0.2	mm	
Multi-stage test		Back Pressure		kPa	Side drain	with/ without		
		Load proving ring	0.9618	N/Div	Specimen dia	35.50	mm	
		Strain proving ring	0.01	mm/a Div.	Specimen length	75.00	mm	
		Penetration rate	0.25	mm/min.	Consolidate area	8360.25	mm^2	
				%/ a hour	Consolidate volumn	74197.22	mm^3	

Time		Strain		Load		Pore Press	Sample Volumn			Deviator Stress	Stress
Date	Time	Dial Div.	% strain	Dial Div.	Load (kN)	U (kPa)	V/C reading	V/C diff.	vol.strain(%)	kPa	Ratio
Stage 1	1st stage	0	**0.000**	0	**0.000**		896	0	**0.000**	**0.00**	
Effective P	**Eff. Pressure**	20	**0.267**	7	**0.007**		896	0	**0.000**	**6.79**	
Cell P	**50**	40	**0.533**	33	**0.032**		908	-12	**-0.016**	**31.91**	
Back P	**Cell Press.**	60	**0.800**	98	**0.094**		980	-84	**-0.113**	**94.41**	
	350	80	**1.067**	144	**0.138**		998	-102	**-0.137**	**138.31**	
	Back Press.	100	**1.333**	180	**0.173**		998	-102	**-0.137**	**172.43**	
	300	120	**1.600**	205	**0.197**		955	-59	**-0.080**	**195.96**	
		140	**1.867**	221	**0.213**		861	35	**0.047**	**210.95**	
		160	**2.133**	235	**0.226**		761	135	**0.182**	**224.00**	
		180	**2.400**	243	**0.234**		648	248	**0.334**	**231.35**	
		200	**2.667**	249	**0.239**		532	364	**0.491**	**236.79**	
		168	**2.240**	0	**0.000**		890	6	**0.008**		
Stage 2	2nd stage	166	**2.263**	0	**0.000**		1316	0	**0.000**	**0.00**	
Effective P	**Eff. Pressure**	180	**2.454**	165	**0.159**		1362	-46	**-0.062**	**156.38**	
Cell P	**100**	200	**2.727**	305	**0.293**		1368	-52	**-0.070**	**288.23**	
Back P	**Cell Press.**	220	**3.000**	388	**0.373**		1350	-34	**-0.046**	**365.73**	
	400	240	**3.272**	426	**0.410**		1280	36	**0.049**	**400.80**	
	Back Press.	260	**3.545**	448	**0.431**		1207	109	**0.147**	**420.73**	
	300	280	**3.818**	463	**0.445**		1122	194	**0.261**	**434.08**	
		300	**4.091**	473	**0.455**		1038	278	**0.375**	**442.70**	
		320	**4.363**	481	**0.463**		949	367	**0.495**	**449.45**	
		280	**3.818**	260	**0.250**		1357	-41	**-0.055**	**242.99**	
Stage 3	3rd stage	276	**3.821**	0	**0.000**		2017	0	**0.000**	**0.00**	
Effective P	**Eff. Pressure**	280	**3.876**	100	**0.096**		2030	-13	**-0.018**	**93.44**	
Cell P	**250**	300	**4.153**	440	**0.423**		2116	-99	**-0.133**	**409.46**	
Back P	**Cell Press.**	320	**4.430**	567	**0.545**		2157	-140	**-0.189**	**525.83**	
	550	340	**4.707**	695	**0.668**		2178	-161	**-0.217**	**642.49**	
	Back Press.	360	**4.983**	877	**0.843**		2183	-166	**-0.224**	**808.33**	
	300	380	**5.260**	931	**0.895**		2183	-166	**-0.224**	**855.60**	
		400	**5.537**	970	**0.933**		2183	-166	**-0.224**	**888.83**	
		420	**5.814**	1000	**0.962**		2155	-138	**-0.186**	**913.98**	
		460	**6.368**	1043	**1.003**		2084	-67	**-0.090**	**948.59**	

500	**6.921**	1073	**1.032**	2002	15	**0.020**	**971.17**
540	**7.475**	1095	**1.053**	1914	103	**0.139**	**986.36**
580	**8.029**	1112	**1.070**	1826	191	**0.257**	**996.86**
620	**8.583**	1122	**1.079**	1729	288	**0.388**	**1001.08**
680	**9.413**	1132	**1.089**	1585	432	**0.582**	**1002.78**
780	**10.797**	1127	**1.084**	1328	689	**0.929**	**986.53**
880	**12.182**	1089	**1.047**	1107	910	**1.226**	**941.31**
980	**13.566**	1040	**1.000**	945	1072	**1.445**	**886.74**

Multistage triaxila test : Perth sand

SOIL MECHANIC LABORATORY CURTIN UNIVERSITY OF TECHNOLOGY

Triaxial Consolidation

Project: PhD Project | Source of Soil: N/A | test type: CU, CD, C-QU, PERM.

Location: Curtin University of Technology | tested Date: | Specimen type:

Soil Description: Perth Sand | Test By: Peerapong Jitsangiam | **Undisturbed, Remoulded, Recompacted**

Remark: Multi-stage test

Effective Pressure		kPa	no. of membrane	1	
Cell Pressure		kPa	Membrane thinkness	0.2	mm
Back Pressure		kPa	Side drain	with/ without	
Load proving ring	0.9618	N/Div	Specimen dia	36.40	mm
Strain proving ring	0.01	mm/a Div.	Specimen length	74.20	mm
Penetration rate	0.25	mm/min.	Consolidate area	8480.76	mm^2
		%/ a hour	Consolidate volumn	77174.95	mm^3

Time		Strain		Load		Pore Press	Sample Volumn			Deviator Stress	Stress
Date	Time	Dial Div.	% strain	Dial Div.	Load (kN)	U (kPa)	V/C reading	V/C diff.	vol.strain(%)	kPa	Ratio
Stage 1	1st stage	0	**0.000**	0	**0.000**		0	0	**0.000**	**0.00**	
Effective P	**Eff. Pressure**	20	**0.270**	25	**0.024**		0	0	**0.000**	**23.06**	
Cell P	**100**	40	**0.539**	60	**0.058**		-4	-4	**-0.005**	**55.18**	
Back P	**Cell Press.**	60	**0.809**	123	**0.118**		-60	-60	**-0.078**	**112.73**	
	300	80	**1.078**	187	**0.180**		-92	-92	**-0.119**	**170.86**	
	Back Press.	100	**1.348**	236	**0.227**		-94	-94	**-0.122**	**215.03**	
	200	120	**1.617**	268	**0.258**		-94	-94	**-0.122**	**243.52**	
		140	**1.887**	286	**0.275**		-12	-12	**-0.016**	**259.44**	
		160	**2.156**	298	**0.287**		79	79	**0.102**	**269.90**	
		180	**2.426**	304	**0.292**		171	171	**0.222**	**274.91**	
		168	**2.264**	0	**0.000**		68	68	**0.088**		
Stage 2	2nd stage	160	**2.204**	0	**0.000**		0	0	**0.000**	**0.00**	
Effective P	**Eff. Pressure**	180	**2.479**	370	**0.356**		-49	-49	**-0.063**	**333.45**	
Cell P	**200**	200	**2.755**	560	**0.539**		-55	-55	**-0.071**	**503.22**	
Back P	**Cell Press.**	220	**3.030**	620	**0.596**		7	7	**0.009**	**556.01**	
	400	240	**3.306**	638	**0.614**		105	105	**0.136**	**571.25**	
	Back Press.	260	**3.581**	643	**0.618**		217	217	**0.281**	**574.92**	
	200	280	**3.857**	646	**0.621**		300	300	**0.389**	**576.57**	
		252	**3.471**	10	**0.010**		60	60	**0.078**	**8.93**	
Stage 3	3rd stage	250	**3.487**	0	**0.000**		0	0	**0.000**	**0.00**	
Effective P	**Eff. Pressure**	270	**3.766**	520	**0.500**		-27	-27	**-0.035**	**462.59**	
Cell P	**300**	290	**4.045**	840	**0.808**		-38	-38	**-0.049**	**744.98**	
Back P	**Cell Press.**	310	**4.324**	950	**0.914**		30	30	**0.039**	**840.83**	
	500	330	**4.603**	972	**0.935**		134	134	**0.174**	**858.95**	
	Back Press.	350	**4.881**	975	**0.938**		234	234	**0.303**	**860.20**	
	200	370	**5.160**	975	**0.938**		323	323	**0.419**	**858.67**	
		390	**5.439**	971	**0.934**		409	409	**0.530**	**853.59**	
		410	**5.718**	968	**0.931**		485	485	**0.628**	**849.28**	

	430	**5.997**	963	**0.926**	549	549	**0.711**	**843.10**
	450	**6.276**	958	**0.921**	618	618	**0.801**	**836.99**
	500	**6.974**	950	**0.914**	768	768	**0.995**	**825.44**
	550	**7.671**	942	**0.906**	894	894	**1.158**	**813.70**
	600	**8.368**	935	**0.899**	1015	1015	**1.315**	**802.82**
	650	**9.066**	928	**0.893**	1126	1126	**1.459**	**791.90**
	700	**9.763**	921	**0.886**	1217	1217	**1.577**	**780.84**
	750	**10.460**	912	**0.877**	1295	1295	**1.678**	**768.02**
	800	**11.158**	912	**0.877**	1375	1375	**1.782**	**762.84**